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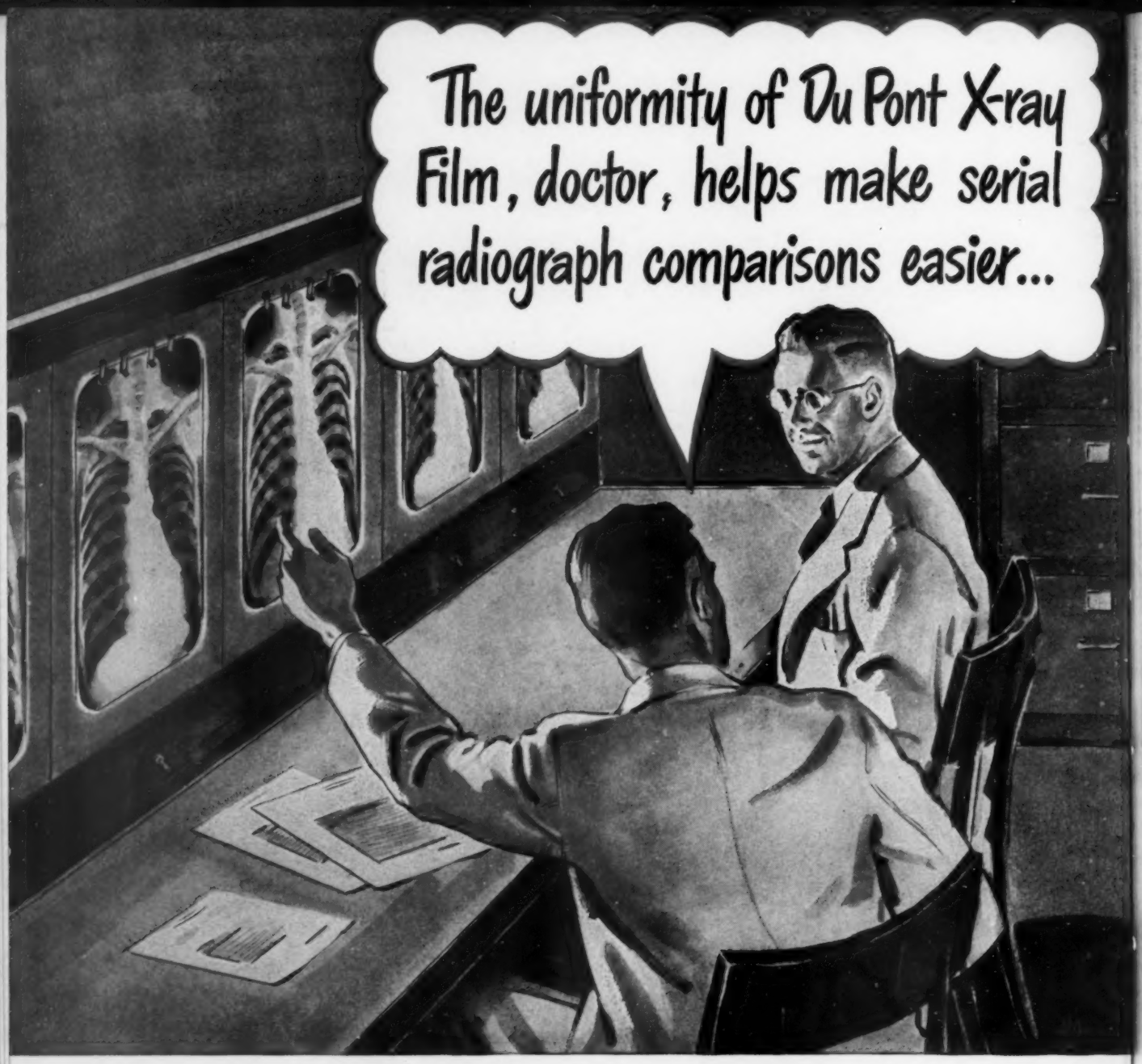

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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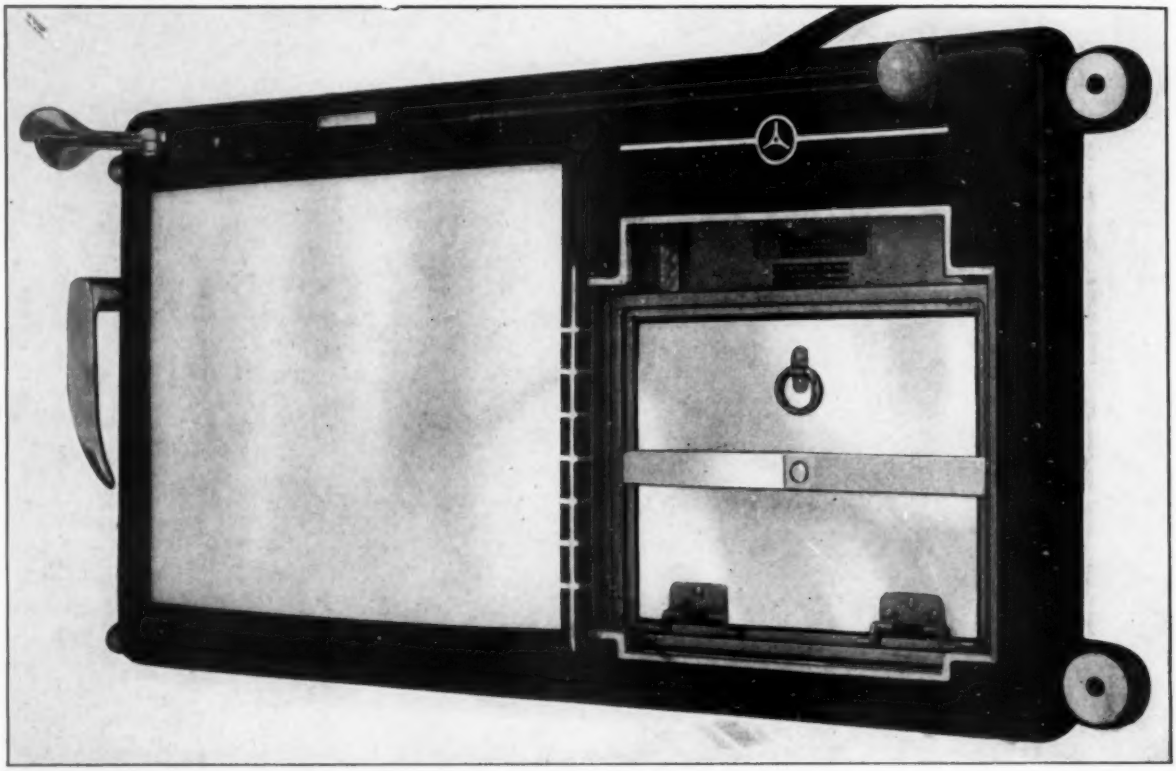

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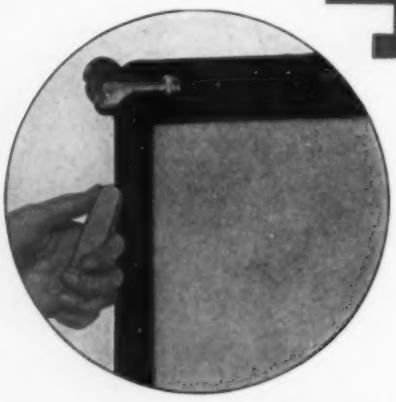

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VOL. 59 MARCH, 1948 No. 3

PNEUMOENCEPHALOGRAPHIC DIAGNOSIS IN THE PRESENILE DEMENTIAS*

By PAUL CHODOFF, M.D., ALEXANDER SIMON, M.D., *and* WALTER FREEMAN, M.D.

WASHINGTON, D. C.

THE information provided by the pneumocencephalogram as to the presence or absence of cerebral atrophy is of great value in the differentiation of the presenile dementias from other conditions causing somewhat similar symptoms in middle life. Its value as a diagnostic means for differentiating among the various types of processes found in the presenile group is less definite and has been the subject of opposing reports. Specifically in the difficult differential diagnosis between Pick's disease and Alzheimer's disease, air studies have been considered on the one hand to be pathognomonic and on the other to be of little value. The former opinion is based largely on the work of Flügel[5] who in 1932 reported on 24 cases of presenile dementia with encephalographic findings. The characteristic finding was symmetrical or asymmetrical ventricular enlargement without displacement especially involving the anterior horns. The type of distribution of the cortical air was considered to be a differential point between Pick's disease and Alzheimer's disease, the air in the former taking the shape of large confluent masses over the frontal and temporal lobes and appearing in the latter as broad stripes over the entire convexity. The value of Flügel's report is vitiated by the fact that pathologic basis for the diagnoses was lacking in all except 6 cases in which brain puncture biopsies were performed. No reproductions of the encephalograms were presented in the paper. This work has, however, gained the sanction of authority and as recently as 1946 Jarvis[7] states that "the air encephalogram is of great diagnostic value showing circumscribed cortical atrophy in Pick's disease in contrast to the diffuse type of atrophy in Alzheimer's."

The subject was critically reviewed by Romano and Miller[12] in 1940. They stated that with the exception of one case recorded by Bumke and Foerster[3] they were unable to find any reproductions of encephalograms in published reports of Alzheimer's disease. Papers by Lemke,[8] Nichols and Weigner,[11] Benedek and Lehoczky[1] and Fromenty[6] all contained reproductions of encephalograms from cases of Pick's disease. Romano and Miller[12] concluded that the encephalographic pic-

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ture in Pick's disease was fairly uniform, being characterized by dilatation of the lateral ventricles, increase of intergyral air spaces more marked in the frontal and temporal areas, and confluent masses of air over the frontal and temporal lobes. On the other hand, an encephalogram made four years before death in the case of Malamud and Boyd[10] showed only moderate and symmetrical dilatation of the lateral ventricles while at autopsy there was circumscribed symmetrical atrophy of the temporal lobes.

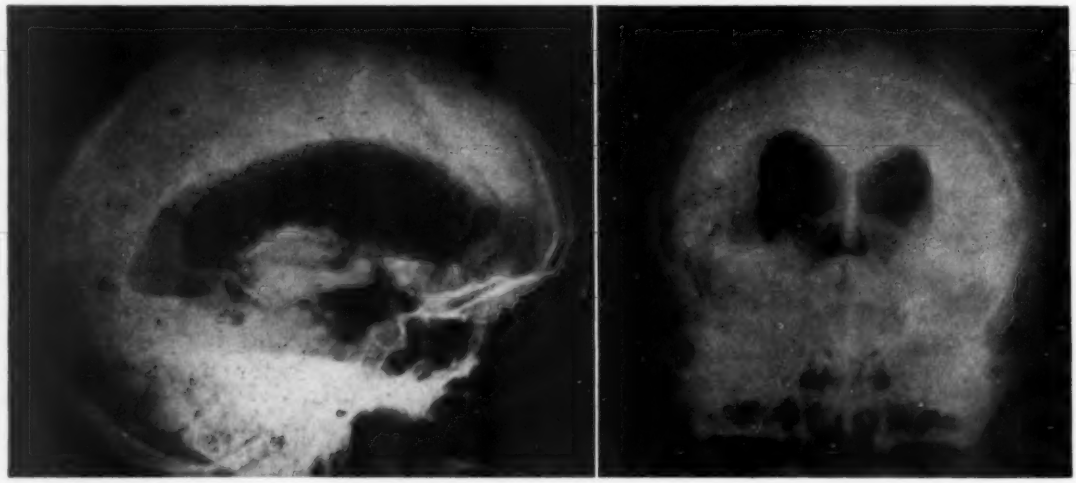

FIG. 1. Case 1 showing marked and uniform dilatation of both lateral ventricles without distortion or displacement. Very little extracortical air is visible. Pathologically this was a case of Alzheimer's disease

The usefulness of air encephalography in the differential diagnosis of Pick's disease and Alxheimer's disease has also been criticized on pathologic grounds. Thus, both Bouton[2] and McMenemey[9] point out that some cases of Pick's disease do not show gross lobar atrophy while local accentuation of atrophy may be quite striking in some cases of Alzheimer's disease. This latter finding has been emphasized by Rothschild and Kasanin[13] in 2 of 5 autopsied cases. Referring to its use in the differentiation of the various members of the presenile group, Critchley[4] calls the encephalogram a "treacherous short cut to diagnosis."

In the course of a clinicopathologic study in the presenile dementias based on a group of 10 patients seen over a number of years at St. Elizabeth's Hospital, the opportunity arose to evaluate the role of the pneumoencephalogram both in the delimitation of the presenile group from other cases and in the differential diagnosis of Pick's disease and Alzheimer's disease. In all cases the diagnosis of presenile dementia was made on the basis of a progressive organic dementing process having its onset in middle life without evidence of specific infectious, luetic, toxic or arteriosclerotic etiology. Nine of the 10 cases have died and autopsies have been performed on all but one of the cases.

CASE REPORTS

CASE 1. J. L. B., a male, white, aged fifty-eight, was admitted to St. Elizabeth's Hospital on May 6, 1939, because of progressive intellectual deterioration and personality change which had first been noticed in 1936 when he was fifty-five years old. After hospitalization his course was steadily retrogressive and after some years of a vegetative existence he died on May 1, 1941.

Air encephalography, performed on December 19, 1939, revealed marked uniform dilatation of the lateral ventricles with an almost complete absence of visible extracortical air (Fig. 1).

At autopsy there was great dilatation of the

ventricular system with great reduction of the subcortical white matter and thinning of the cortex. There was no focal lobar atrophy. The microscopic findings were compatible with Alzheimer's disease.

Case II. G. A., a female, white, aged fifty-seven, was admitted to St. Elizabeth's Hospital on June 7, 1937, because of the gradual development of faulty memory, difficulty in reading, untidiness and paranoid delusions. The first symptoms were noted in 1927 at the age of forty-seven. After admission there was progressive deterioration of all intellectual functions and complete personality change. Symptoms had first been noted in 1934 at the age of forty-seven. After admission she developed profound speech difficulties, spontaneous laughing and focal neurological signs. After progressive deterioration of all intellectual functions had occurred, she died on October 6, 1942.

Air encephalography revealed moderate dilatation of the lateral and third ventricles especially the left. Subdural air was visible over the convexity on the right and between the hemispheres. Some extracortical air was irregularly distributed (Fig. 3).

At autopsy the brain presented a remarkably

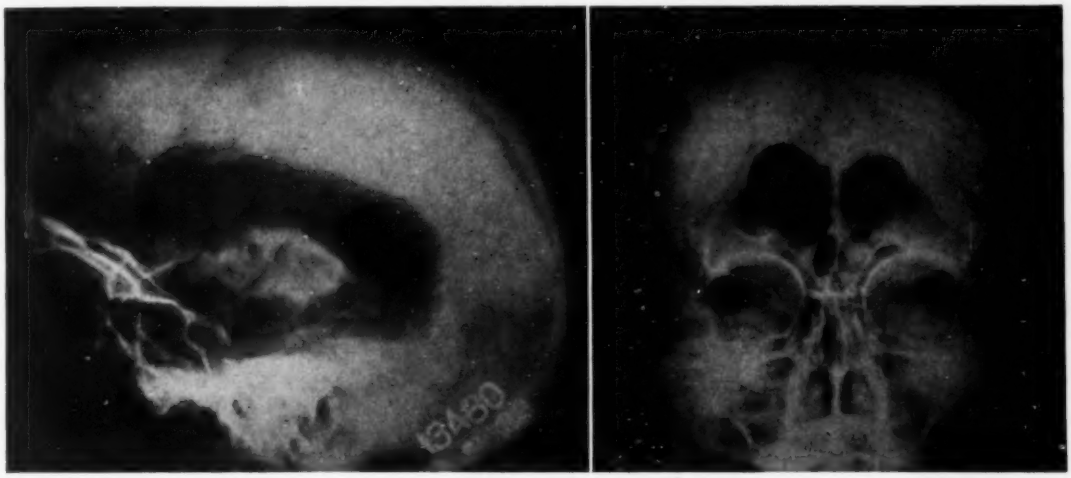

Fig. 2. Case II showing marked dilatation of the lateral ventricles, especially the right, without displacement, A prefrontal mass of air might suggest frontal lobe atrophy and a diagnosis of Pick's disease. However. the gross and microscopic pathologic findings were those of Alzheimer's disease.

eventuating in mutism. During the final stage, she was completely bed-ridden and vegetative, showing a mask-like facies, bradykinesis, rigidity and grasping and sucking reflexes. She died on November 16, 1942.

On April 7, 1939, a pneumoencephalogram revealed marked dilatation of the lateral ventricles especially on the right. There was a mass of air in the prefrontal region (Fig. 2).

At autopsy there was a considerable degree of symmetrical dilatation of the entire lateral ventricular system but no focal lobar atrophy, and microscopic findings were characteristic of Alzheimer's disease.

Case III. H. J., a female, white, aged fifty-four, was admitted to St. Elizabeth's Hospital on September 12, 1941, because of confusion, disorientation, emotional instability, irritability

normal appearance with no external evidence of cortical atrophy. On section the entire ventricular system was moderately dilated, especially the anterior horns. The microscopic findings were those of Alzheimer's disease.

Case IV. J. C., a female, white, aged fifty-five, was admitted to St. Elizabeth's Hospital on July 28, 1937, because of extreme agitation. Symptoms of excitability, bulimia, overactivity and confusion had gradually developed since 1929 at the age of forty-two. After admission she was constantly and purposelessly agitated, her speech was voluminous but stereotyped. She became blind and in spite of a voracious appetite her weight fell to 93 pounds before her death on February 2, 1946.

Air encephalography on November, 1941, showed bilateral ventricular dilatation of a

moderate degree more marked on the right. Aside from a small amount of air over the right convexity which may have been subdural, the extracortical pathways were very poorly filled.

At autopsy there was a suggestion of bilateral frontal lobe atrophy, but this was not marked. Microscopically, argentophile plaques were numerous although neurofibrillary cell changes were infrequent. The picture was that of Alzheimer's disease.

CASE V. L. L., a colored woman, aged fifty-seven, was admitted to St. Elizabeth's Hospital on July 31, 1936, because of gradual and progressive mental deterioration which had first been noted as unusual forgetfulness seven years previously at the age of fifty. Speech became meager, she was disoriented and apathetic and displayed gross memory defects. Deterioration progressed to a mute vegetative stage which persisted until she died suddenly on August 6, 1941.

Air encephalography on October 30, 1936, revealed marked dilatation of the lateral ventricles, more marked on the left and an absence of air over the convolutions.

At autopsy, there was very marked dilatation of the entire ventricular system, more pronounced on the left and especially in the posterior and inferior horns. There was considerable arteriosclerotic change in the cerebral arteries and an old infarct of the left temporal lobe. Microscopically, in addition to the changes characteristic of cerebral arteriosclerosis, there were typical findings of Alzheimer's disease.

CASE VI. A. E., a female, white, aged sixty-five, was admitted to St. Elizabeth's Hospital on May 10, 1940, because of marked impairment of all intellectual functions. The onset had been six years previously at the age of fifty-nine. When admitted she was mute, agitated and untidy and during her hospital stay she developed tremors, grasping, groping and sucking reflexes. Death occurred on January 22, 1942.

An air encephalogram on July 23, 1940, revealed ventricular dilatation more marked on the left. Little extracortical air was visible except for a small amount at the frontal poles.

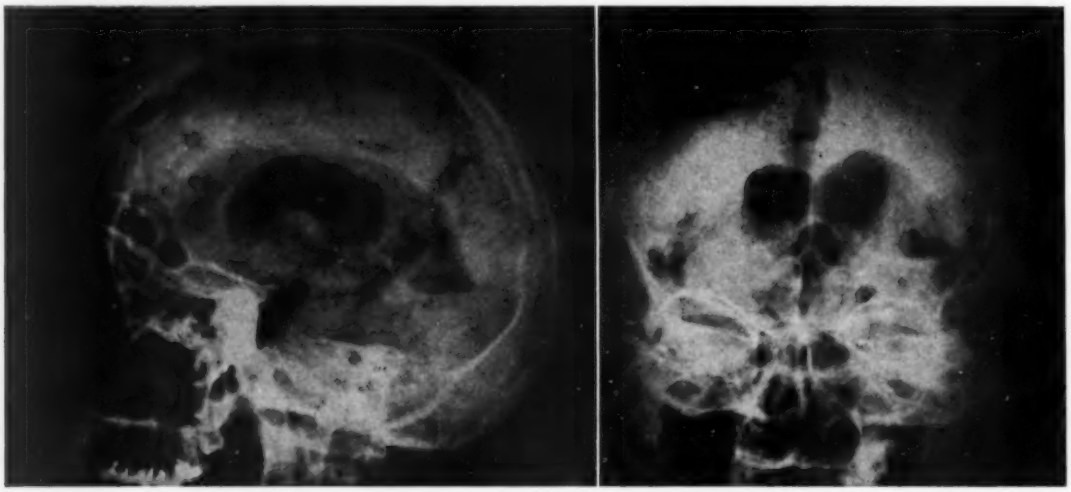

FIG. 3. Case III showing moderate dilatation of the lateral and third ventricles. A considerable amount of subdural air is visible and there is also some increase in the extracortical markings. Microscopic findings were those of Alzheimer's disease.

Gross examination of the brain revealed no external cortical atrophy. The ventricles were bilaterally dilated, more so on the left. The left temporal cortex was only 2 mm. thick with almost complete disappearance of subcortical white matter. Microscopically the findings were those of Pick's disease.

CASE VII. D. B., a female, white, aged forty-seven, was admitted to St. Elizabeth's Hospital on March 26, 1940, because of the gradual onset two years previously of impairment of judgment, carelessness and untidiness, bulimia, polydipsia and urinary incontinence. Memory was relatively retained but she lost the ability

to write and calculate. After hospitalization she lost ground steadily and progressively. In May, 1940, she developed continuous myoclonic tremors localized in the right buttock and thigh. Focal neurological signs appeared, and she became mute, bedridden and vegetative. During the final period there were grasping and groping reflexes, periods of spontaneous laughing and crying and complete loss of contact with the outside world. After an episode of hyperpyrexia and status epilepticus, she died on July 30, 1942.

Air encephalography with the removal of 270 cc. of spinal fluid revealed enormous dilatation of the lateral ventricles particularly in the anterior portion. Both showed fluid levels. Only a thin shell of brain substance separated the anterior horns from the skull. Very little extracortical air was visible (Fig. 4).

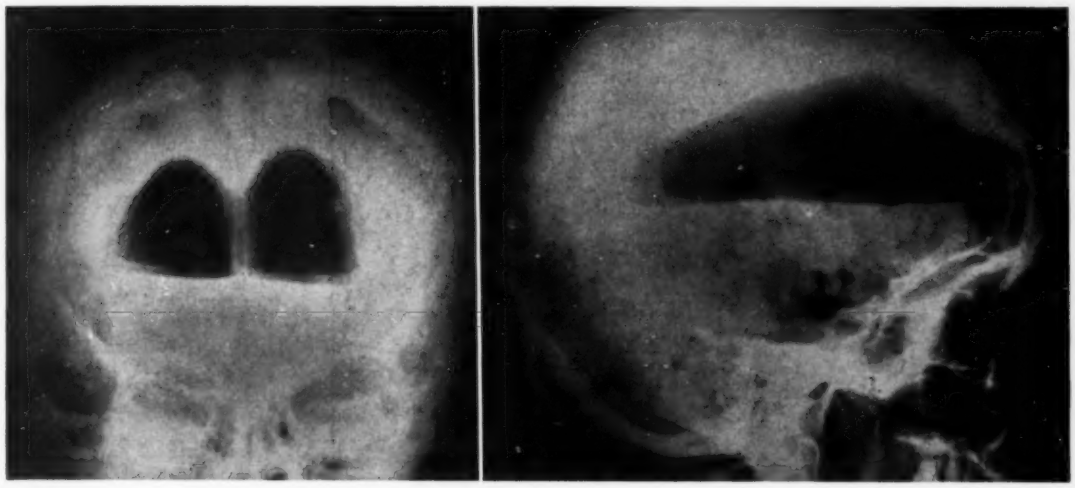

Fig. 4. Case vii showing enormous symmetrical dilatation of the lateral ventricles particularly in the anterior portions. Very little extracortical air is visible. Pathologically, there were diffuse areas of partial demyelination of the subcortical white matter.

At autopsy there was massive dilatation of the lateral ventricles especially the anterior horns with only a trace of subcortical white matter visible frontally. Microscopically the cortex was relatively well preserved and the principal lesion consisted of extensive demyelinization of the subcortical white matter, involving all but the U fibers.

Case viii. J. K., a male, white, aged fifty-three, was admitted to St. Elizabeth's Hospital on December 18, 1936, because of defects in judgment, irritability and gross defects in memory. After admission he was described as being agitated, depressed and confused. He became increasingly untidy and dilapidated until death on December 8, 1940, after a febrile illness.

On November 29, 1940, an air encephalogram showed bilateral ventricular dilatation more marked on the right and principally involving the anterior portions of both lateral ventricles. There was a good deal of air visible in the basal cisterns but very little extracortically.

At autopsy the frontal lobes, especially the left, were flattened and atrophic. On section there was marked dilatation of the anterior horns and the third ventricle but very little dilatation of the inferior and posterior horns. Microscopically there were moderate degenerative changes in the cortical neurons especially of the frontal lobes but no changes characteristic of Pick's or Alzheimer's disease were present. The substantia nigra was extensively degenerated.

Case ix. G. N., a male, white, aged forty-seven, was admitted to St. Elizabeth's Hospital on June 25, 1939, with a history of marked personality change since 1937. His early defects were mainly in the sphere of judgment although intellectual functions were greatly impaired. There has been only slow progression since his admission and he is still up and about although he displays profound mental dilapidation.

An air encephalogram in October, 1940, revealed dilatation of both lateral ventricles expecially the left with little extracortical air being visible.

In each of the 9 cases reported, air encephalography revealed dilatation of the lateral ventricles without displacement. Although there was some tendency for the enlargement to be most marked in the anterior portions, whenever the posterior and inferior horns were visualized they were also dilated. In one case the size of the lateral ventricles was approximately the same on the two sides. In 4 the dilatation was greater on the right side, in 4 on the left. The enlargement of the lateral ventricles varied from the slight but definite degree seen in Case IV to the massive amount present in the encephalogram of Case VII where only a thin shell of cortex remained at the frontal pole. The third ventricle could be seen to be dilated in 2 cases.

In 7 of the 9 cases very little extracortical air was visible and no conclusions could be drawn as to the presence or absence of localized or diffuse cortical atrophy. A fairly dense mass of air at the frontal pole was visible in the lateral views in Case II. The encephalograms of Case III showed a considerable amount of diffusely distributed extracortical air. Although a good deal of this probably represents subdural masses the appearance is somewhat suggestive of generalized cortical atrophy.

A comparison of the encephalographic and gross anatomic findings is of interest in the 8 autopsied cases. In general, the actual condition of the ventricles was accurately mirrored in the encephalograms, although there were some minor discrepancies such as the fact that in 2 cases (Cases II and III) what proved to be bilaterally equal ventricular dilatation appeared asymmetrical in the encephalograms while in one (Case VIII) the anatomically smaller ventricle appeared to be the more greatly dilated one in the air study. In 6 cases there was nothing in the encephalographic pictures to indicate gross lobar atrophy and in 4 of these this was confirmed at autopsy. However, the 2 cases (Cases IV and VIII) which did present some degree of visible atrophy of the frontal lobes were also among those failing to show any appreciable amount of extracortical air. On the other hand, the roentgen appearance of Case II which indicated frontal lobe atrophy and of Case III which suggested diffuse cortical atrophy were both misleading since no gross lobar atrophy was found in either at autopsy. We are unable to offer a reasonable explanation of why so little extracortical air was visible in 6 cases. Since no arachnoidal adhesions were found, there was apparently no blockage of the subarachnoid pathways.

It is thus apparent that this study fails to substantiate the formulation of Flügel as to the value of the air encephalogram in the differential diagnosis of Pick's disease and Alzheimer's disease. The presence or absence of local or diffuse lobar atrophy could not be correctly inferred from a study of the encephalograms and in fact the rather remarkable paucity of visible extracortical air made any interpretation unsatisfactory. The futility of relying on the roentgen ray to differentiate between Pick's disease and Alzheimer's disease is further indicated by a study of the pathologic material. Five of the 8 autopsied cases were diagnosed as belonging to the Alzheimer group. A mass of prefrontal air, suggestive of Pick's disease, was seen in the encephalograms of one of these (Case II) while in only one were there any of the diffuse broad stripes and masses of extracortical air described as typical of Alzheimer's disease. One case (Case VI) was considered, on the basis of the microscopic findings, to be an example of Pick's disease. In this there was no gross lobar atrophy and on encephalography very little extracortical air was seen and certainly none of the broad confluent masses described by Flügel as characteristic of this condition. Two of the cases (Cases VII and VIII) were pathologically obscure encephalopathies which did not fit into either the Pick's or

the Alzheimer's group. This illustrates the point that the presenile dementias are not synonymous with Pick's and Alzheimer's diseases and that a number of other conditions must be included. Thus, any attempt to differentiate encephalographically between the two may be invalidated by the possibility that the particular case being studied may pathologically belong to neither.

Although air encephalography was of little value in differentiating among the various members of the presenile group, it was very successful in separating the degenerative presenile cases from other conditions such as the functional psychoses and space taking lesions. The picture of uniform or asymmetrical ventricular dilatation without displacement was constantly present and was of considerable value in confirming the clinical impression in all of the cases.

SUMMARY AND CONCLUSIONS

1. The literature on the pneumoencephalographic findings in the presenile dementias has been reviewed.

2. Nine cases belonging to this group in all of which air encephalograms were performed are presented. Eight of these came to autopsy and the pathologic and encephalographic findings are compared and the results are analyzed.

3. Uniform or asymmetrical ventricular dilatation without displacement was found in every case and is the characteristic pneumoencephalographic appearance in the presenile dementias.

4. The appearance of the extracortical pathways is of little or no value in distinguishing between Pick's disease and Alzheimer's disease. Reasons for this are discussed.

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REFERENCES

1. Benedek, L., and Lehoczky, T. Clinical recgonition of Pick's disease; report of 3 cases. *Brain*, 1939, *62*, 104–122.
2. Bouton, S. M., Jr. Pick's disease: clinicopathologic case reports. *J. Nerv. & Ment. Dis.*, 1940, *91*, 9–30.
3. Bumke, O., and Foerster, O., Editors. Presenile Demenzerkrankungen. In: Handbuch der Neurologie. Vol. VII, Part 2, pp. 374–375, J. Springer, Berlin, 1936.
4. Critchley, M., and others. Discussion on mental and physical symptoms of presenile dementias. *Proc. Roy. Soc. Med.*, 1933, *26*, 1077–1091.
5. Flügel, F. E. Die Encephalographie als neurologische Untersuchungsmethode. *Ergebn. d. inn. Med. u. Kinderh.*, 1932, *44*, 327–433.
6. Fromenty, L. l'Encéphalographie dans la maladie de Pick. *Ann. méd.-psychol.*, 1939, *97*, pt. 2, 64–71.
7. Jarvis, G. In: Kaplan, Oscar J., Editor. Mental Disorders in Later Life. Stanford University Press, 1945.
8. Lemke, R. Ein Beitrag zum Krankheitsbild der Pickschen Atrophie. *Arch. f. Psychiat.*, 1934, *101*, 623–636.
9. McMenemey, W. H. Critical review; dementia in middle age. *J. Neurol. & Psychiat.*, 1941, *4*, 48–79.
10. Malamud, N., and Boyd, D. A., Jr. Pick's disease with atrophy of temporal lobes. *Arch. Neurol. & Psychiat.*, 1940, *43*, 210–222.
11. Nichols, I. C., and Weigner, W. C. Pick's disease—specific type of dementia. *Brain*, 1938, *61*, 227–249.
12. Romano, J., and Miller, W. C. Clinical and pneumoencephalographic studies in pre-senile dementia. *Radiology*, 1940, *35*, 131–137.
13. Rothschild, D., and Kasanin, J. Clinicopathologic study of Alzheimer's disease. *Arch. Neurol. & Psychiat.*, 1936, *36*, 293–321.

ROENTGENOLOGICAL ASPECT OF SARCOIDOSIS

By MAJOR ALFRED J. ACKERMAN, M.C.
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SARCOID lesions of specific organs were thought to be separate disease entities and were described under various names depending on their localization. Greater experience, however, led to recognition of these entities as a generalized disorder affecting the skin, lymph nodes, uveal tract and parotid gland, lungs, and skeletal system. Recent observations tend to show that visceral organs are perhaps more frequently involved.

Sarcoidosis presents clinical features of a chronic infectious granuloma. The constitutional symptoms are rarely severe, but the disease persists often for years; successively more organs become affected, and occasionally spontaneous healing occurs after one or more relapses. The definite diagnosis of sarcoidosis depends almost entirely on the characteristic histopathological findings. The lesions consist histopathologically of tuberculoid accumulations of epithelioid cells frequently surrounded by a thin layer of lymphocytes. Within the epithelioid follicles occasional giant cells of the Langhans type are seen. Necrosis and caseation are absent, although single epithelioid cells may show some slight necrobiotic changes; exudative features and polymorphonuclear cells are absent. It is interesting to note that in the United States the disease is observed much more frequently in the colored than in the white race. The reason for this does not appear clear since the disease is not at all rare on the Continent.

We shall discuss only the roentgenological aspects of sarcoidosis, and refer the reader to a rather extensive literature dealing with other considerations of this problem.

The pulmonary lesions were first described in 1915 by Kuznitzky and Bitthorf; Jüngling described the skeletal changes associated with sarcoidosis in 1919 and again in 1928 and considered them as osteitis tuberculosa cystoides. The phalanges, metacarpals, and metatarsals are the usual sites of involvement. Since then, the roentgenologic characteristics of the disease have been repeatedly described in the American and foreign literature.

Most writers concerned with this subject emphasize the variability of the roentgenological findings. There are great individual differences in the distribution, extent, and character of the lesions. This—it is felt—is due in a large measure to the fact that they represent different stages of evolution of the disease. Thus the outstanding roentgenological features observed in the early stage may become superseded by other changes during the subsequent phases of regression and progression. The relatively asymptomatic course of sarcoidosis, of which the roentgenologic findings are often the first evidence, makes it difficult to observe early intrathoracic alterations. In many cases, the process is well advanced when the patients are first seen. Extended observation, however, permits one to follow the evolution of the thoracic lesions through successive stages of development. These observations demonstrate rather convincingly the fluctuations in the course of the disease. While new lesions may appear at any time, the older ones do not always remain stationary. They do show quite often evidence of regression or a change in their morphological characteristics. Not infrequently, all phases of the disease are demonstrable on a single roentgenogram. One finds enlargement of the mediastinal nodes, miliary infiltration, areas of fibrosis, and confluent areas of patchy infiltration. A discussion of the roentgenological features of intrathoracic sarcoid manifestations must, therefore, consider the whole course of the disease rather than stress the indi-

vidual changes varying with the developmental phase of the disease.

Enlargement of the intrathoracic lymph nodes is an outstanding feature of sarcoidosis. The mediastinal and tracheobronchial nodes are usually involved. This results in a striking enlargement of the mediastinal shadow and a more or less marked prominence of the lung roots. The bilateral, frequently symmetrical, enlargement of the nodes ranging from moderately prominent mediastinal or hilar shadows to large "tumor masses" extending far into the lung fields causes remarkable roentgenological appearances. Although it is true that bilateral involvement is exceedingly common in some instances, unilateral lymphoadenopathy has been observed. The enlarged nodes do not seem to affect significantly adjacent structures. One does not ordinarily find evidence of pressure on large vessels, the trachea, or esophagus. We did, however, observe a traction diverticulum in one case of mediastinal adenopathy due to sarcoidosis. The intrathoracic nodes show a definite tendency to spontaneous regression. This is sometimes so marked as to cause almost complete disappearance of the nodes. The mediastinal adenopathy has only too often been the cause of diagnostic errors; it was commonly misinterpreted as a lymphoblastoma, and the correct diagnosis was arrived at only after histopathological studies of peripheral nodes revealed sarcoidosis. The disproportion between the extensive anatomical changes and the paucity of clinical symptoms deserves special emphasis as an aid in proper evaluation of the roentgenological manifestations of this disease. At least this has been our experience in the Army where sarcoidosis is usually detected during routine examinations of the chest.

The pulmonary manifestations of sarcoidosis are not pathognomonic per se. They are rarely uniform, and no single type of infiltration can be definitely attributed to an early or late phase of the disease. During the intermediate stages of the disease any one or any combination of the commonly distinguished groups of infiltration can occur. Although sarcoidosis usually affects the pulmonary parenchyma bilaterally, there are cases with unilateral involvement on record. The infiltration may show a diffuse widespread distribution, or it may be limited in scope, confined to the roots of the lungs or the basal portions of the lung fields. Pulmonary changes are occasionally seen without concomitant enlargement of the mediastinal or tracheobronchial nodes. Of course, one cannot state definitely that these nodes were not enlarged in an earlier stage of the disease and, when absent, had regressed to a more normal size.

Reisner distinguished three main types of infiltration associated with sarcoidosis: (1) diffusely disseminated small nodular infiltration; (2) diffuse or localized peribronchial fibrous infiltration, and (3) coalescent, patchy infiltration.

The diffusely disseminated infiltrates consist of discrete, small, nodular foci resembling in appearance and distribution those observed either in acute miliary or in chronic forms of hematogenous tuberculosis. Sometimes the individual nodules, which occur in the interstitial lymphoid tissue of the pulmonary parenchyma, attain a larger size possibly due to coalescence of smaller foci. The lesions may be distributed uniformly throughout both lungs, or they may be confined to the parahilar or basal segments of the lungs.

The diffuse or localized infiltrations of a linear or strand-like character seem to follow the distribution of the bronchovascular pattern and are characterized roentgenologically by prominent root trunks and peripheral markings. A combination of the disseminated nodular form and the linear "peribronchial-perivascular" pattern occurs not infrequently.

Coalescent patchy densities are usually observed alongside widespread peribronchial-perivascular and nodular infiltrations. Lesions of this type can be widely distributed, but they are usually more frequent in the mid-zones and basal segments.

The various types of pulmonary lesions

observed in sarcoidosis represent only manifestations of different stages of evolution. It is only to be expected that, in a disease of such a chronic nature with frequent remissions and relapses, there should be transitions from one type of infiltration into another and that any combination of infiltrations should be observed concurrently. A complete absorption of some areas of infiltration is seen almost invariably in cases remaining under prolonged clinical observation. The developmental cycle of pulmonary sarcoidosis is difficult to determine, but perhaps a general pattern as described by Reisner can be recognized. According to him, the disseminated nodular forms are most likely associated with an early stage of the disease. The more bizarre forms such as the linear interstitial fibrotic type and the conglomerate densities can best be regarded as expressions of an intermediate or late phase. These latter changes are probably irreversible.

The disseminated nodular forms are of a reversible nature as they show a definite tendency to spontaneous regression. In some cases the regression is only partial; while certain areas of infiltration show resolution, other portions of the lung fields exhibit little or no change.

A discussion of thoracic manifestations of sarcoidosis must also include a consideration of the cardiovascular system. The myocardium and pericardium have been occasionally affected by this disease. Clinically, arrhythmias, conduction defects, cardiac enlargement, and right cardiac failure have been observed. Pathological examinations revealed in several instances invasion of the myocardium or pericardium by sarcoid. Right cardiac enlargement was demonstrated in one of our own cases which showed also significant electrocardiographic changes. It is perhaps reasonable to assume that even in absence of direct cardiac invasion the chronic peribronchovascular fibrosis may obstruct the normal pulmonary circulation and result in a chronic cor pulmonale.

Skeletal changes are said to occur relatively frequently (approximately 20 per cent) in association with sarcoidosis. We did not observe alterations in our series of cases. The bone lesions—when present—are so characteristic that they may be regarded as practically pathognomonic for sarcoidosis. The lesions, resembling small cysts, are found in the phalanges of the fingers and toes. Two main types of bone lesions can be distinguished: (1) the circumscribed form which consists of sharply defined "punched-out" areas of rarefaction, circular or oval in shape, usually located within the cancellous portion of the bone without evidence of bone reaction, and (2) the diffuse form which produces a reticular appearance of the bone due to multiple small irregular areas of rarefaction. In this type, large portions of bone are usually involved with frequently resulting alteration of its size and shape. The shaft is widened and the cortex is thinned out.

Nineteen cases of sarcoidosis were observed by us during the last three years; all of them occurred in members of the Armed Forces. Some of them have served for several years and saw overseas duty. We would like to report briefly 4 cases representative of the disease. In one case there was involvement of the lacrimal glands, skin, and the lungs.

REPORT OF CASES

Case 1. A twenty-one year old Negro male was admitted to the hospital from the Separation Center where a roentgen examination of the chest revealed an enlargement of the mediastinum.

The patient had no complaints and was in good health throughout his service in the Army. The family history was not contributory. The physical examination was essentially negative. Laboratory examination showed normal red and white blood cell counts, normal sedimentation rate, and a normal serum protein with an AG ratio 2:1. A tuberculin test was negative.

Roentgen examination of the chest showed a bilateral enlargement of the paratracheal and parabronchial lymph nodes and a very discrete

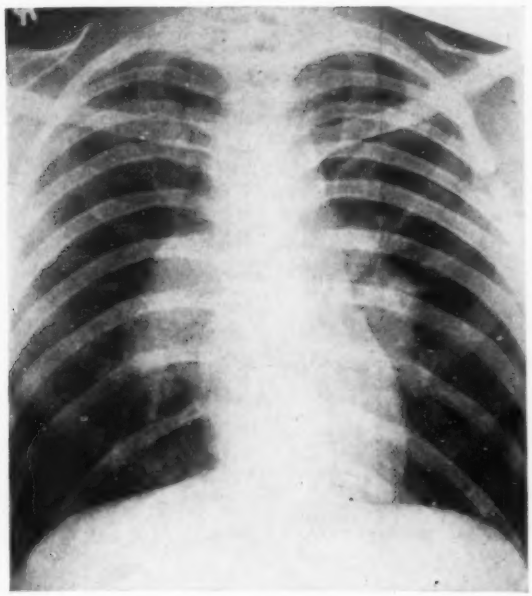

Fig. 1. Case I. The tracheobronchial and mediastinal nodes are enlarged. There is a miliary infiltration in the right infraclavicular region.

Fig. 2. Case I. Lateral view demonstrating the mediastinal adenopathy.

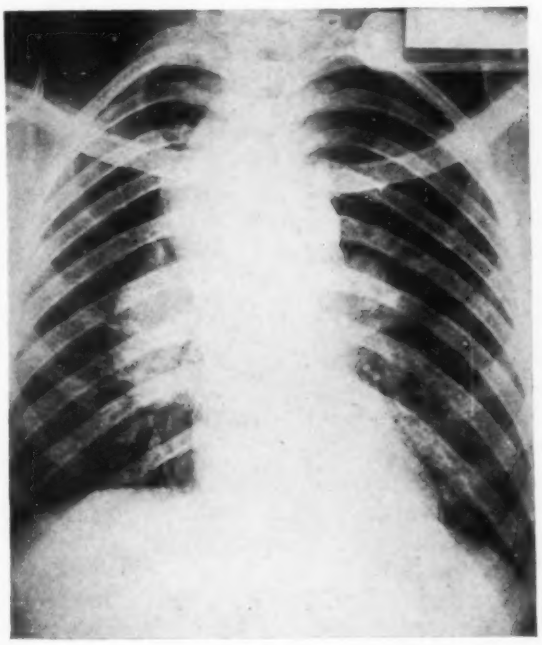

Fig. 3. Case II. The tracheobronchial and mediastinal nodes are enlarged. Discrete miliary infiltration in both lower lung fields.

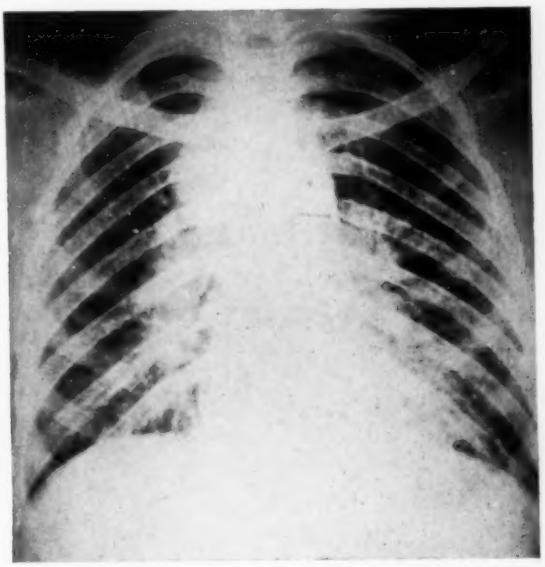

Fig. 4. Case II. Some regression of the original adenopathy. The pulmonary infiltration is more extensive; it is now coarser, fibronodular in character.

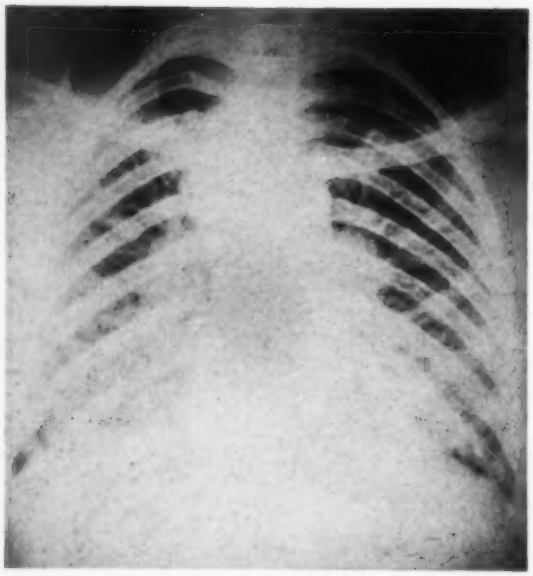

Fig. 5. Case II. The pulmonary infiltration is fairly generalized. At the right base it is patchy in character and coalescent.

miliary infiltration in the infraclavicular portion of the right lung field. A diagnosis of mediastino-pulmonary sarcoidosis was made which was verified by biopsy of a peripheral lymph node.

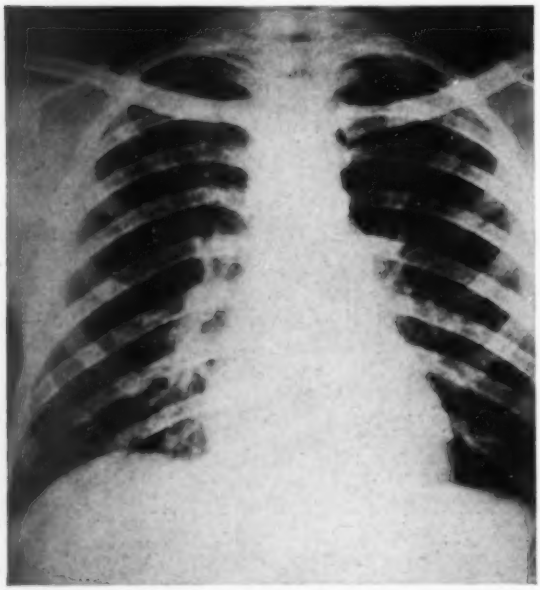

Fig. 6. Case III. Fairly diffuse fibronodular infiltration in both lung fields. The mediastinal nodes are not significantly enlarged.

Case II. A nineteen year old Negro male was admitted to the hospital in December, 1946. The patient was referred from the Separation Center where a roentgen examination of the chest disclosed a mass in the mediastinum.

Except for the usual childhood diseases, there was no history of illness in the past. The family history was non-contributory. The patient was in good health at the time of admission. Physical examination was essentially negative. There was no peripheral adenopathy. Laboratory examination showed normal red and white blood cell counts. The differential count was 73 per cent neutrophiles, 18 per cent lympho-

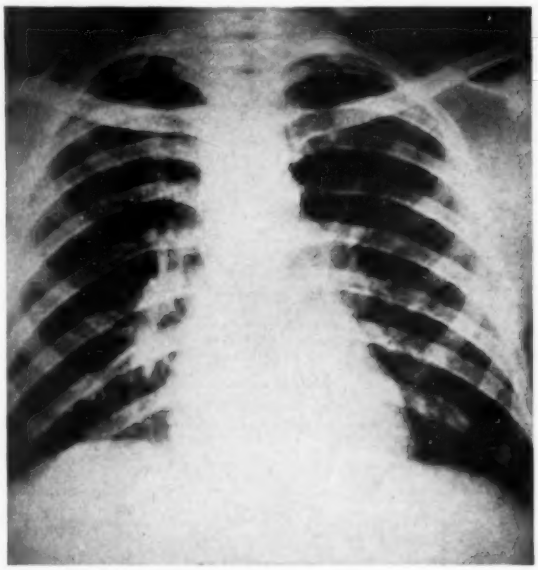

Fig. 7. Case III. Recent exacerbation with coalescent patchy infiltration at the right base.

cytes, and 9 per cent eosinophiles. The serum protein was 7.5 gm. (albumin, 4.9 gm., globulin, 2.6 gm. and AG ratio 1.9). The sedimentation rate was 15 mm. per hour. The tuberculin test was negative.

Roentgen examination of the chest showed bilateral enlargement of the mediastinal nodes and a discrete miliary infiltration in both lower lung fields. During three months of observation the mediastinal nodes regressed moderately, but the infiltration had extended farther and became more coarsely nodular in character.

A biopsy of a cervical lymph node revealed sarcoidosis.

Case III. A twenty year old Negro male sergeant was admitted to this hospital with

numerous "nodular swellings" over the entire body and a generalized lymphadenopathy.

The family and past history were not contributory. The patient appeared in no distress; there was no fever, pain, or cough. The skin lesions, which appeared approximately seven months prior to admission to the hospital, showed no significant change in size, consistency, or color since the time they were first observed. The patient was returned to the United States for separation from the Armed Forces.

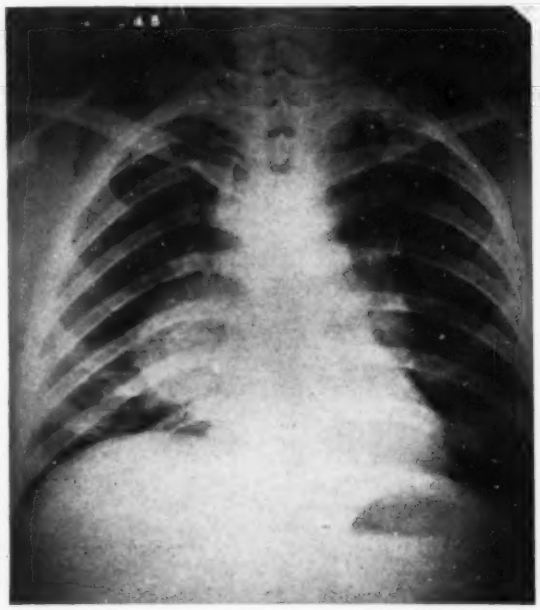

Fig. 8–14. Case IV. Series of roentgenograms taken within a fourteen month period, showing the fluctuating character of the disease with regressions and exacerbations and a change of the cardiac shadow suggestive of cor pulmonale.

Physical examination showed an enlargement of the lacrimal glands and hypertrophy of the conjunctivae, ptosis of the eyelids, enlarged cervical nodes, and widely disseminated cutaneous lesions, most numerous on the trunk. The internal organs showed no abnormality.

Laboratory Findings: The red blood cell count was 4.2 million, white blood cell count, 5,300, hemoglobin 80 per cent; the differential smear showed no significant deviation from normal. There was a rather diffuse peribronchial fibronodular infiltration throughout the right lung field and the inner zone of the left lung field. The mediastinal nodes were somewhat enlarged but not significantly so. Observation over seven months showed some regression of the pathologic process in the right lower lung field.

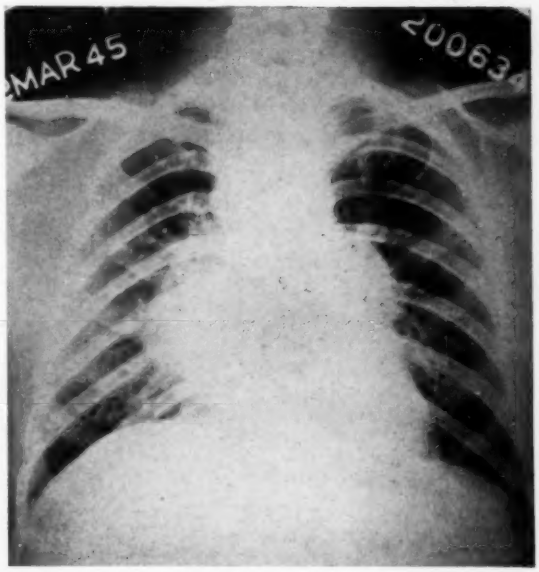

Fig. 9

A biopsy of a skin lesion and a cervical node confirmed the clinical and roentgenological diagnosis of sarcoidosis.

Case IV. A twenty-five year old white male master sergeant was admitted to the hospital because of chills and fever of about four weeks' duration.

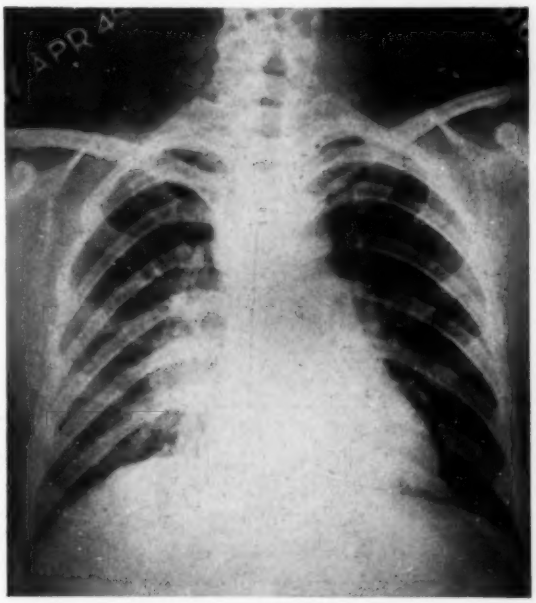

Fig. 10

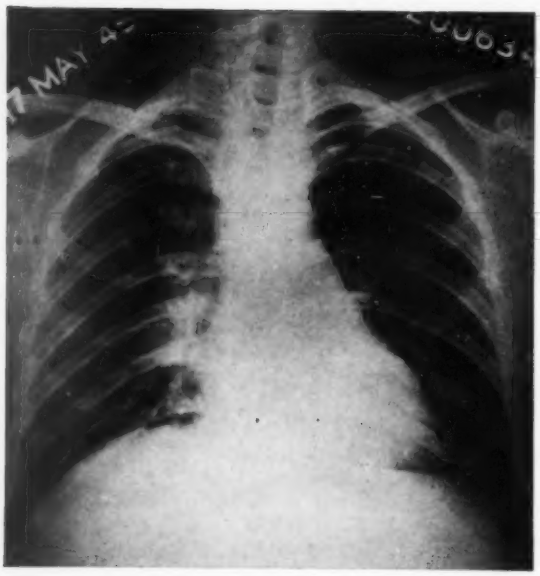

Fig. 11

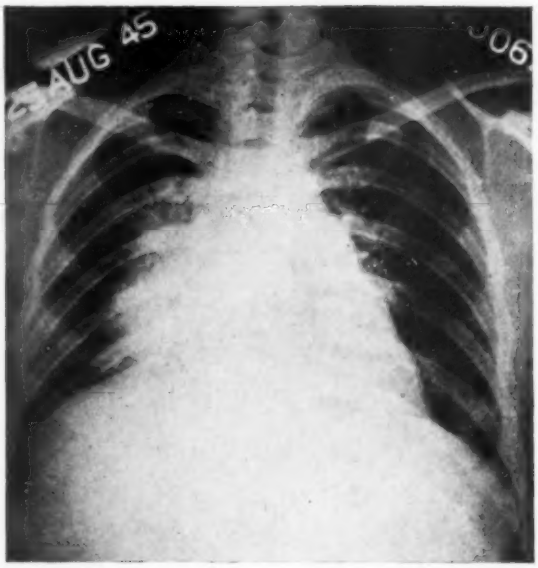

Fig. 12

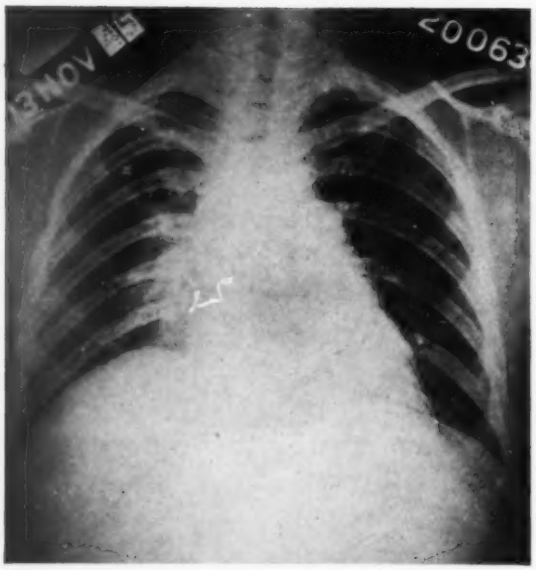

Fig. 13

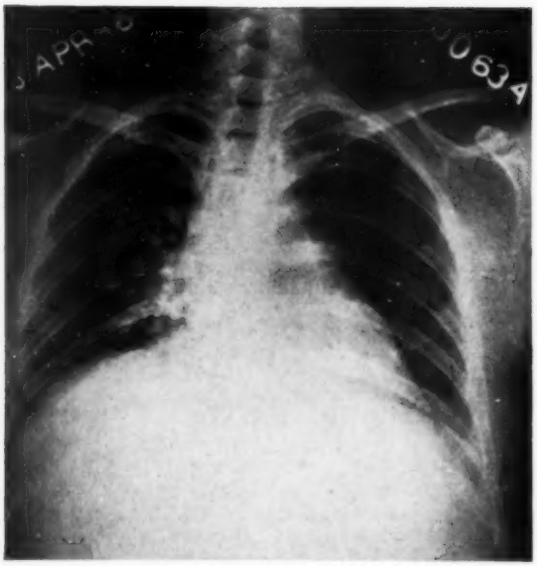

Fig. 14

Family and Occupational History. The patient's mother was a cardiac patient. One of his brothers was an "asthmatic"; two uncles and one grandfather had had tuberculosis. In civilian life the patient had worked as a cleaner and painter of tanks for an oil refinery. At the onset of his illness he had served in the Army for two and one-half years in the capacity of a butcher and a mess sergeant.

Present Illness. About one year before admission, the patient was hospitalized for a cold. Subsequently, he complained of "heaviness" in his chest. About four weeks before admission to this hospital, he began to have episodes of chills and fever, for which he was briefly observed at another hospital. At that time, the physical examination was negative. The roentgen examination showed well rounded mediastinal masses of increased density along the trachea and the main bronchi. The red

blood cell count was 4.9 million, white blood cell count 8,750; the differential smear revealed 52 per cent neutrophiles, and 48 per cent lymphocytes. The sedimentation rate was 38 mm. and later 22 mm. (corrected).

Further observation in this hospital showed complete absence of any significant findings.

Laboratory Examination. The red blood cell count averaged about 4–5 million. The white blood cell count averaged around 4,000. Differential smears showed from 1 to 21 per cent eosinophiles, averaging between 10 and 15 per cent eosinophiles. The lymphocytes varied from 2 to 24 per cent; the monocytes varied from 1 to 3 per cent; hemoglobin was within normal limits. The urine was negative. Sedimentation rate always remained within normal limits. Serum protein on admission was 7.2 gm. per 100 cc., with 5.1 gm. of albumin and 2.1 gm. of globulin. Eight months after admission, the serum protein was 6.5 gm. per 100 cc. with 5 gm. of albumin and 1.6 gm. of globulin. Twelve months after admission, total protein was 6.8 gm. per 100 cc., with 3.6 gm. of albumin and 3.2 gm. of globulin. The Kahn test was negative. Complement fixation tests for coccidioidomycosis were negative in all dilutions. The patient gave no reaction to 0.01 mg. old tuberculin and 1 mg. old tuberculin.

Serial roentgenologic studies of the chest revealed marked enlargement of the mediastinal nodes and a fibronodular infiltration in both lower lung fields. The mediastinal nodes regressed slowly; the pulmonary infiltration showed marked fluctuation, first extending to involve also the upper portions of the lung fields, and later receding with resulting clearing of the left lung field. After a period of regression, new areas of infiltration developed in the hilar regions; the infiltration was of fibrous character. A right cardiac enlargement could also be observed. This exacerbation of the pulmonary involvement was later again followed by a significant remission. The left mediastinal nodes became reduced to almost normal size.

A biopsy of a peripheral node showed changes characteristic of sarcoidosis.

CONCLUSIONS

1. The observation of nineteen cases of pulmonary sarcoidosis confirmed essentially the findings reported in the literature.

2. The patients whom we saw in the Army showed practically no clinical evidence of disease and were detected usually in the course of routine examinations.

3. The mediastinal and pulmonary lesions show fairly marked fluctuations characterized by regression of the enlarged nodes and dissemination and less conspicuous regression of the pulmonary infiltrations. These may appear as miliary, nodular, and occasionally confluent patchy densities scattered over large areas of the pulmonary parenchyma.

4. There is no definite correlation between the morphologic changes and clinical symptoms produced by them.

5. Absence of significant mediastinal adenopathy does not necessarily rule out pulmonary sarcoidosis or prove that these nodes are free from the disease. A previously existing adenopathy may have simply regressed sufficiently so that it is no longer recognizable.

6. In view of the clinical experiences the prognosis in cases of pulmonary sarcoidosis should always be guarded.

7. A definite diagnosis of sarcoidosis can be established only by a biopsy.

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REFERENCES

1. Bernstein, S. S., and Sussman, M. L. Thoracic manifestations of sarcoidosis. *Radiology*, 1945, *44*, 37–43.
2. Horton, R., Lincoln, N. S., and Pinner, M. Noncaseating tuberculosis. *Am. Rev. Tuberc.*, 1939, *39*, 186–203.
3. King, D. S. Sarcoid disease as revealed in the chest roentgenogram. Am. J. Roentgenol. & Rad. Therapy, 1941, *45*, 505–512.
4. Longcope, W. T., and Pierson, J. W. Boeck's sarcoid (sarcoidosis). *Bull. Johns Hopkins Hosp.*, 1937, *60*, 223–296.
5. Meisels, E. The course of Besnier-Boeck's disease of the lungs in serial roentgenograms. Am. J. Roentgenol. & Rad. Therapy, 1940, *44*, 564–567.
6. Pinner, M. Noncaseating tuberculosis. *Am. Rev. Tuberc.*, 1938, *37*, 690–728.
7. Reisner, D. Boeck's sarcoid and systemic sarcoidosis (Besnier-Boeck-Schaumann disease) *Am. Rev. Tuberc.*, 1944, *49*, 289; 437.

HEBERDEN'S NODES

VII. THE ROENTGENOLOGICAL AND CLINICAL APPEARANCE OF DEGENERATIVE JOINT DISEASE OF THE FINGERS*

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A STUDY of the gross and roentgenographic appearance of Heberden's nodes was undertaken because these enlargements of the finger joints are typical examples of degenerative joint disease. Since details of finger joints lend themselves so well to delineation by photographic and roentgenographic investigation it was hoped that such study might contribute to a better understanding not only of Heberden's nodes but also to the general problem of degenerative joint disease which constitutes such a large part of the total arthritic problem.

Heberden[1] wrote, "What are those little hard knobs about the size of a small pea, which are frequently seen upon the fingers particularly a little below the top, near the joints? They have no connection with the gout. . . . " Charcot[2] stated "the pea-like enlargements . . . are nothing but osseous nodules which exist normally at the head of the second phalanx on the dorsal aspect; only the size of these nodules is considerably increased by the growth of new layers of bone." Modern students employ the term Heberden's nodes to denote degenerative joint disease of the fingers. Heberden's original description included only one stage of the disease which often presents a different appearance varying widely from the above picture. There may be pea-sized knobs. There may also be enlargements or bony overgrowth with flexion and deviation deformity of the terminal phalanges. Heberden's nodes are confined to the terminal joint but are often associated with degenerative joint disease of the proximal interphalangeal joints of the fingers. When this occurs, an erroneous diagnosis of mixed arthritis is sometimes made because of the generally accepted fallacy that arthritis of the proximal joints is due to rheumatoid arthritis.

Heberden's nodes occur in two different ways. They may arise as the result of direct injury to the terminal interphalangeal joint; in this case they represent a true traumatic arthritis. In such instances one, or at most only two adjacent fingers are involved. At the onset of such traumatic Heberden's nodes, swelling is noted to appear immediately or shortly after a definite and vividly recalled injury. Soreness lasts several days or weeks and the condition becomes stabilized in a few months and remains unchanged for years. The deformity does not extend to adjacent fingers. Such a history is typical in men with one or two enlarged fingers.

Under other circumstances and particularly in women, the enlargements arise spontaneously without history of injury. They begin in one finger and spread in months or years to other fingers. These constitute the so-called idiopathic Heberden's nodes with which this study is principally concerned.

Observation of nearly 7,000 individuals[3] revealed that this condition was nearly ten times as common in women as in men, that it was more common in white people than in Negroes and that its incidence was definitely related to age, being rare in young people but affecting about 30 per cent of white women in the ninth decade. It was further demonstrated that the occurrence of this form of degenerative joint disease was strongly influenced by heredity, having been found twice as commonly in the

* From the Departments of Medicine and Radiology of Western Reserve University, School of Medicine at City Hospital, Cleveland, Ohio. Presented before the Mid-Western Conference of Radiology, Cleveland, Ohio, Feb. 14–15, 1947.

mothers and three times as commonly in the sisters of affected women as was to be expected in the general population.[4] The mode of inheritance seemed to be best explained as dependent upon a single chromosome factor which was sex influenced, being dominant in women and recessive in men.[5]

Little or no attention has been devoted to detailed observation of the roentgenographic changes produced by this disease. The most extensive account so far discovered has been given by Scott.[6] He has

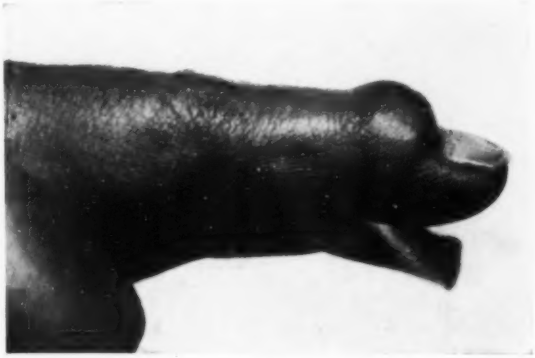

Fig. 1*A*. Case 1. Right index finger showing tumor mass over dorsum of terminal joint which was fluctuant, translucent, slightly tender, but not hot.

described the earliest changes as simple narrowing of the joint space. This is later followed by spur formation and misalignment of the terminal phalanx. A more advanced stage is indicated by broadening of the base of the terminal phalanx, increased density of the end of the bone and irregularity of the joint surface.

The present study is based on observations, case histories, photographs and roentgenograms of over 100 patients with Heberden's nodes and material assembled during the course of previous studies on different phases of the disease. Particular emphasis will be devoted to the clinical and roentgenographic appearance of the condition and the time relationships of different stages of the disease. Lateral roentgenograms of the fingers will be emphasized because these have been previously neglected and are largely unknown.

CASE REPORTS

Case 1. Mrs. C. C., first seen at forty-five years of age because of hypertension, was found to have tender, raised, split pea-sized nodules on the posterior surfaces of the distal phalangeal joints of the fingers of two years' duration. Photograph of the right index finger (Fig. 1*A*), at the age of forty-seven, shows a tumor mass over the terminal joint which was fluctuant, trans-

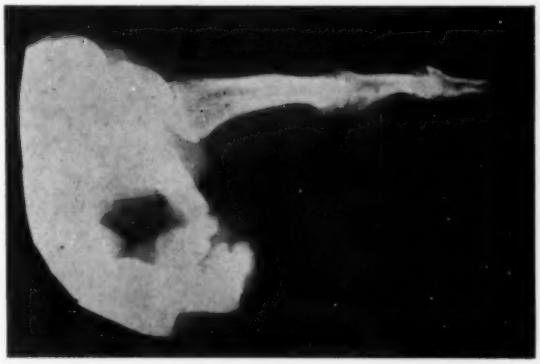

Fig. 1*B*. Case 1. Lateral roentgenogram of right index finger showing bulbous enlargement anteriorly and posteriorly of the distal end of the middle phalanx and spur formation on the dorsal and palmar aspects of the proximal end of the distal phalanx.

lucent, slightly tender but not hot. A diagnosis was made of synovial lesion of the skin, and the cyst was evacuated. Photograph of this entire hand shows enlargements also of the middle and little finger with flexion deformity of the latter. Roentgenogram of the right index finger in lateral view (Fig. 1*B*) shows definite spur formation on the dorsal and palmar aspects of the distal end of the middle phalanx and from the dorsal aspect of the proximal end of the distal phalanx.

Posteroanterior roentgenogram of the right hand at the age of forty-seven (Fig 1*C*) shows slight changes only in the index and little fingers. There is decreased joint space and slight spur formation. There is slight condensation of bone along the joint line of the index finger. The joint surfaces are regular.

Six years later, at the age of fifty-three, there were well marked enlargements of all fingers of both hands. Photograph of the right hand then (Fig. 1*D*) shows the pea-shaped nodules particularly well in the index and middle fingers. A roentgenogram (Fig. 1*E*) shows marked de-

FIG. 1*C*. Case 1. Posteroanterior view of right hand shows narrowed terminal joint spaces, beginning spur formation and slight bone condensation of index and little fingers.

FIG. 1*D*. Case 1. Six years later shows pea-shaped nodules on dorsum of terminal joints, particularly well marked in index and middle fingers.

FIG. 1*F*. Case 1. Lateral views show proximally extending spur formations anteriorly and posteriorly on adjacent ends of terminal and middle phalanges giving the appearance of a ball and socket joint.

FIG. 1*E*. Case 1. Posteroanterior view of right fingers shows deformities of the terminal joint lines, spur formations with broadening of the lateral diameters of the proximal ends of the distal phalanges. The distal ends of the middle phalanges show an irregular arrangement of the trabeculae producing a foamy appearance.

formity of the joint lines, irregularity of joint space and spur formation with broadening of the lateral diameter of the proximal end of the distal phalanges. The detailed structure of the bone of the distal portion of the second phalanges shows an irregular arrangement of the trabeculae producing a foamy appearance. The proximal interphalangeal and the metacarpophalangeal joints are apparently normal.

Lateral views of the finger joints are seen in Figure 1*F*. The alteration of joint structure is striking. Marked spur formation extending proximally from both dorsal and palmar surfaces of the proximal end of the distal phalanges gives the appearance of the section of a ball and socket joint. There is also spur formation from the distal ends of the middle phalanges. Even the ring finger which is only slightly deformed clinically, in the posteroanterior roentgenogram contains a spur on the dorsal aspect of the distal phalanx.

Case II. Mrs. E. H., aged forty-two, had noticed enlargements of her fingers for four years. Photograph of the right hand (Fig. 2*A*) shows enlargement of all the terminal joints except the little finger. This enlargement takes the shape of a transverse ridge rather than "small pea-shaped nodules." The hand is otherwise normal. A roentgenogram (Fig. 2*B*) shows little or no abnormality. There is narrowing of the ulnar half of the joint space of the index finger and narrowing of the joint space of the ring finger. There is also a small punched out area 2 mm. in diameter on the radial side of the distal end of the second phalanx of the ring finger. The roentgenogram is otherwise normal. A photograph taken sixteen months later is indistinguishable from the one shown. At this time, posteroanterior roentgenograms show only decreased joint space. The lateral roentgenogram (Fig. 2*C*) shows a large spur arising from the dorsal aspect of the proximal end of the terminal phalanx of the ring finger. This spur is large enough to increase the joint surface by about 60 per cent. Very small spurs are

Fig. 2*A*. Case II. Dorsal enlargements of transverse ridge type of terminal joints except little finger present for four years.

Fig. 2*B*. Case II. Dorsipalmar roentgenogram shows only slight narrowing of terminal joints of index and ring fingers and small "punched-out" area on radial side of head of the middle phalanx of the ring finger.

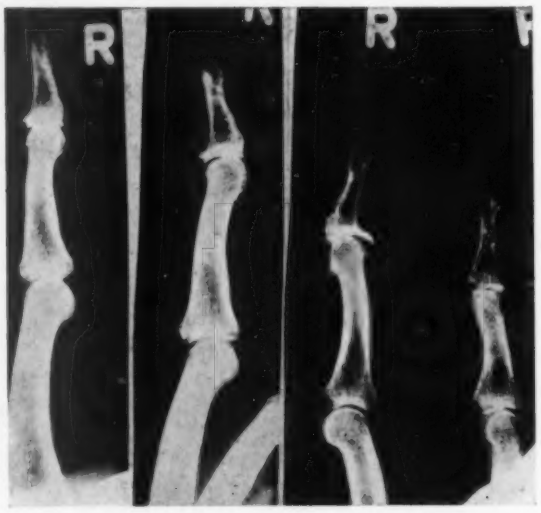

Fig. 2*C*. Case II. Lateral projection made sixteen months later shows spur formations on proximal ends of terminal phalanges except in little finger. Posteroanterior projection failed to reveal spurs.

seen in the same position of the index and middle fingers and also on the palmar and the dorsal surfaces of the distal end of the middle phalanges. The little finger is normal.

This case illustrates that marked deformities may be apparent clinically in the finger joints with little or no evidence of bone change visible in posteroanterior roentgenograms.

Case III. Mrs. B. H. was a woman, aged forty-seven, whose fingers had been enlarged for two years. Examination showed considerable enlargement of the terminal joints with flexion deformity of both little fingers, slightly smaller enlargement of the left ring and right middle fingers but little or no change of either index fingers or the left middle or right ring fingers.

Posteroanterior roentgenogram of the right hand (Fig. 3*A*) shows little abnormality. In the terminal joints the index finger is almost completely normal showing only a very small spur about 1 mm. long on the ulnar side of the proximal end of the distal phalanx. In the middle finger the base of the distal phalanx is definitely broadened, the joint surface here being in-

Fig. 3*A*. Case III. Dorsipalmar view shows slight changes of spurring of index finger, broadening and narrowing of joint of middle finger, narrowing of joint space of ring finger.

Fig. 3*B*. Case III. Photograph of right hand forty-two months later shows increase in size of terminal joint of middle, ring and little fingers with flexion deformity of middle finger.

Fig. 3*C*. Case III. Dorsipalmar view shows progressive changes of spur formation and increased width of the base of the distal phalanges of the middle, ring and little fingers.

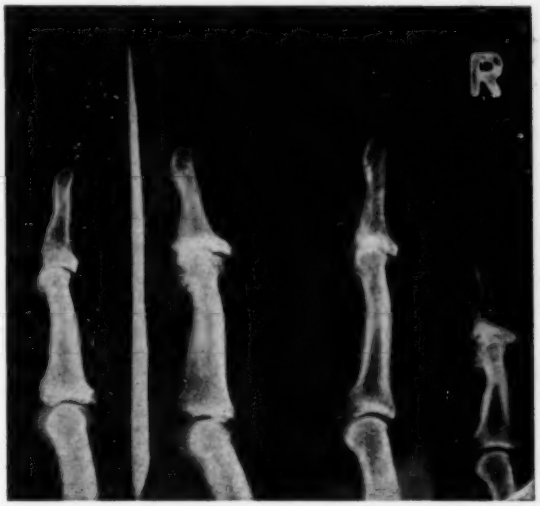

Fig. 3*D*. Case III. Lateral views show better the degree of spur formations and narrowing of the space of the terminal joint of the middle, ring and little fingers. Spurs are present on the middle as well as the distal phalanges.

creased in density and the joint space is narrowed. The distal end of the second phalanx is not altered. The ring finger shows only decrease in joint space. The little finger shows marked change with broadening of the bone ends, irregularity of joint surface and decrease in joint space.

Photograph of the right hand forty-two months later (Fig. 3*B*) shows marked increase in size of the terminal joint of the middle, ring and little fingers. There is also flexion deformity of the middle finger. A roentgenogram at this time (Fig. 3*C*) shows increase in the width of the base of the distal phalanges of the middle, ring and little fingers. The joint surfaces of these fingers show increased density of bone, narrowing or obliteration of joint space, and an irregularity of bone trabeculation of the distal end of the middle phalanges of the middle and little fingers, giving them a foamy appearance. The index finger and the other joints of the hand are normal. A lateral view (Fig. 3*D*) shows spur formation from the dorsal aspect of the proximal ends of the distal phalanges most marked in the middle but present in the ring and little finger and absent from the index fingers. Spur formation is also seen from the distal ends of the middle phalanges of all but the index finger.

In this case, marked advancement of the arthritic process was seen over a period of forty-two months. This woman had no other significant arthritis.

Case IV. Mrs. E. P. was a woman aged sixty-two, with Heberden's nodes for fourteen years. Photograph of the right hand (Fig. 4*A*) shows marked enlargements of all terminal joints with flexion deformity. There is in addition obvious enlargement and ulnar deviation of the proximal interphalangeal joint of the index finger. A posteroanterior roentgenogram (Fig. 4*B*) shows marked enlargements of all distal interphalangeal joints with bulbous swelling and foamy rarefaction of the distal ends of the second phalanges. The joint line is obliterated or obscured by the flexion deformity especially marked in the index and middle fingers. The proximal joints are also affected in this case. The joint spaces are normal and the joint surfaces are not distorted but the bones are broadened, the proximal ends of the middle phalanges extending much beyond the distal ends of the proximal phalanges. There is also foamy distortion of the trabeculae here.

The lateral views (Fig. 4*C*) show large spurs from the dorsal surfaces of the base of the distal phalanges of the index, middle and ring fingers,

Fig. 4*A*. Case iv. Photograph of right hand shows marked enlargements of all terminal joints with flexion deformity. Also there is enlargement and ulnar deviation of the proximal interphalangeal joint of the index finger.

Fig. 4*B*. Case iv. Posteroanterior view shows roentgenographic appearance of enlargements of terminal joints with bulbous swellings and foamy trabeculation of distal ends of second phalanges.

slight enlargement of the distal ends of the middle phalanges. A large spur is also seen extending from the dorsal surface of the proximal end of the middle phalanx of the index finger. No other spurs are seen here in the middle, ring or little fingers. The thumb shows no change of the proximal end of the distal phalanx but there are large spurs extending from the dorsal and the palmar surfaces of the distal end of the proximal phalanx.

Fig. 4*C*. Case iv. Lateral views show the extent of spur formations on adjacent ends of middle and distal phalanges of the index, middle and ring fingers. The proximal phalanx of the thumb and the proximal end of the middle phalanx of the index finger are also involved.

Fig. 5*A*. Case v. Photograph showing enlargements and angular deformities of the proximal and distal joints of all the fingers.

Case v. Mrs. M. R. was a woman aged seventy-one, who noticed swelling of her fingers twenty-five years before, involving both the distal and the proximal interphalangeal joints. Photograph (Fig. 5*A*) shows enlargement and the deformity of all the fingers. This is particularly marked in the proximal and distal phalanges which in the index and middle finger are flanked by substantial spurs (Fig. 5*B*) which extend beyond and curve proximally as though to enclose the distal ends of the middle phalanges. The distal ends of middle phalanges show marked bulbous enlargement with the same foamy disarrangement of the distal ends of the middle phalanges which has been described before. The interphalangeal joints are also markedly enlarged with the same broadening of the base and overhanging spurs of the proximal end of the middle phalanges and a similar foamy disarrangement of trabeculation of the distal ends of the proximal phalanges. The metacarpophalangeal joints appear to be completely normal. Lateral roentgenograms (Fig. 5*C*) show marked spur formation from the distal phalanges and marked increase in

Fig. 5*B*. Case v. Posteroanterior roentgenogram shows the marked spur formations, bulbous enlargements and foamy disarrangement of the adjacent ends of bones forming the proximal and distal joints. Soft tissue thickening around the joints is also shown.

diameter of both bones constituting the proximal interphalangeal joints. A roentgenogram of the thumb shows marked bony enlargements which would not be suspected from the photograph.

DISCUSSION

Idiopathic Heberden's nodes are generally considered to be typical examples of degenerative joint disease. It has been variously stated that they are pathognomonic of the disease, or that they establish the diagnosis. Certainly their presence is not necessary to establish that diagnosis. Degenerative joint disease is a disease which lends itself to protean manifestations and it shows marked variations from case to case as to the number and variety of joints involved as well as to the wide differences in the degree of such involvement. Even in advanced cases of Heberden's nodes uniform involvement of all the fingers is rare, individual joints being only mildly altered or even spared entirely. A tabulation of the involved fingers in 150 women with Heberden's nodes showed only 75 per cent of the fingers of the right hand and 72 per cent of the fingers of the left hand are affected. Fifty-five per cent of the ring fingers were involved. The ring finger of the left hand, the wedding ring finger, was least susceptible of all, being involved in only 50 per cent of the cases. The thumbs were so rarely deformed grossly that they were ignored in the tabulation.

Involvement of the proximal interphalangeal joints was encountered much more frequently than had been anticipated. A review of roentgenograms and photographs of 91 sets of hands revealed obvious degenerative joint disease of the proximal interphalangeal joints in 36 patients, or 40 per cent of the cases. Arthritis of proximal interphalangeal joints of the fingers is not pathognomonic of rheumatoid arthritis as has so often been fallaciously stated.

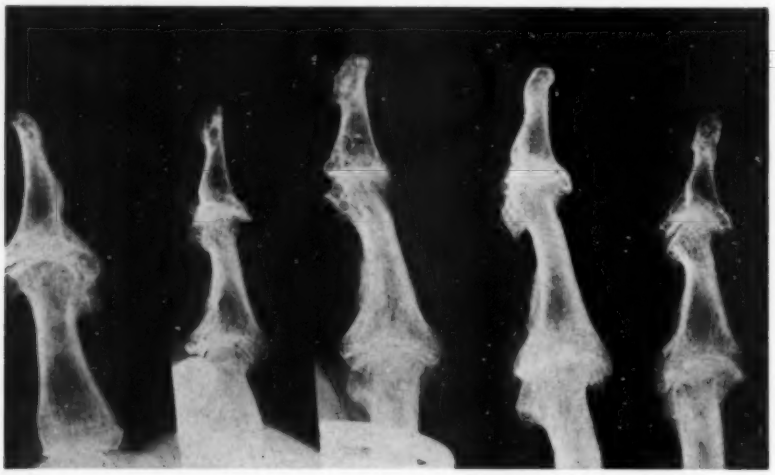

Fig. 5C. Case v. Lateral roentgenogram demonstrates better the extent of spur formation and the increased diameter of the proximal interphalangeal joints. Thumb changes show better than would be suspected from photograph.

The relationship of Heberden's nodes to other degenerative joint disease has been previously considered. In a detailed analysis of 94 women with Heberden's nodes,[7] it was found that 12 of them had definite degenerative joint disease involving other joints. In 19 other instances there were minor joint complaints without definite arthritis and 34 cases had crepitus of the knees. This was in striking contrast to the conditions found in a comparable control series of 109 women of about the same age distribution. They had only 3 instances of joint disease, no recorded minor joint com-

plaints and only 25 cases of crepitus of the knees. The conclusion is inescapable that Heberden's nodes tend to be associated with degenerative joint disease of other joints.

Degenerative joint disease is considered to depend primarily upon degeneration, erosion and finally a wearing away of joint cartilage, followed secondarily by condensation of bone along what had been the subchondral bone plate and at the edges of the joint where spurs are formed. Our roentgenographic studies support this supposition. The earliest observed roentgenographic change is decrease of joint space indicating loss of cartilage. There is later thickening of the bone of the joint surface, evidence of condensation of the subchondral plate and finally spur formation. There is marked distortion of joint surfaces producing serrated or notched surfaces resulting in poor approximation of the opposing joint surfaces. Definite punched out areas suggesting ulcerations of the joint surfaces are seen best in the tangential view at the periphery.

Spur formation is best seen in lateral views. The largest ones seem to arise from the dorsal aspect of the proximal end of the distal phalanx quite near to and seeming to produce an extension of the joint surface itself. Such spurs, if small, may seem to extend only posteriorly and proximally. They arise from what may be assumed to be the attachment of the extensor tendon. Similar but smaller spurs arise from the palmar surface corresponding to the attachment of the flexion tendons. Other bone proliferation does occur, however, quite independent of tendinous attachments. These are seen as extensions of the joint surface of the distal end of the middle phalanges. This is a protrusion proximally from the dorsal and palmar surfaces. In general, these are larger in the palmar surface. When the distal end of the middle phalanx has become greatly enlarged and bulbous this bony spur becomes almost a shelf-like protrusion. Similar changes may be seen in the proximal interphalangeal joints when they are affected.

If examples of Heberden's nodes are observed in order of increasing severity, it will be noted that bone structure suffers progressive alteration, particularly marked at the distal end of the middle phalanx. When viewed in a true posteroanterior projection this is normally shaped like a truncated cone, the sides and top of which are slightly concave. Trabeculation is arranged in a very orderly fashion, the bone elements being about equally spaced and arranged in a longitudinal direction. As the disease progresses the distal end of the middle phalanx loses its truncated cone appearance but becomes gradually widened, blown out and bulbous in shape, more nearly resembling a sphere and the bone trabeculations become very irregular in density, distribution and direction. Numerous instances have been observed of cyst-like areas of rarefaction near the distal end of the middle phalanx, sometimes apparently not communicating with the bone surface. These are often suggestive of gout. Such areas of punched-out cysts seem to be temporary because they are often no longer visible in subsequent roentgenograms.

Distortion of bone structure even at some distance from the joint surface is not uncommon in degenerative joint disease. Notable examples are seen in the hip where the head of the femur becomes mushroomed, broadening out in all diameters with the production of overhanging lips about the edges. At the same time the neck of the femur becomes shortened and the angle of the neck on the shaft of the bone becomes more obtuse. The acetabulum changes shape also to accommodate the distorted head. This is the typical picture of malum coxae senilis.

Review of the study material reveals the fact that soft tissue changes constitute an important factor of the clinical entity of Heberden's nodes. The most striking of these are cystic formations illustrated in extreme degree in Case 1. At least three other such cysts, though not so large, had been opened in our series over joints where

Heberden's nodes subsequently developed. They contained a colorless, gelatinous acellular, amorphous material. This or a similar condition has been described by Gross[8] as recurring, myxomatous, cutaneous cysts of the fingers and toes. According to Gross they represent a degeneration of tendon. Excision is useless because the lesions invariably recur. He believes radiation therapy gives the best hope of permanent relief. He did not note the subsequent development of Heberden's nodes or degenerative joint disease. Experience in our series indicates that such cysts are definitely related to Heberden's nodes.

Soft tissue changes are responsible for enlargement of the finger joints in cases where no distortion and little or no involvement of bone is seen either in posteroanterior or lateral roentgenograms. This is best demonstrated in the early stage of Case II. There is marked enlargement in the shape of a transverse ridge across the dorsum of the joint but the roentgenogram shows only narrowing of joint space. This feature of degenerative joint disease is often apparent in larger joints such as the knee which show a boggy thickening of the synovial tissue producing villous arthritis of the knee.

Cystic nodules in the tendinous attachments, spur formation along tendons, swelling of soft tissue about the joint and disarrangement of bone structure deep in the subchondral spaces all indicate that degenerative joint disease is more than simple deterioration of cartilage and that it involves many structures and areas at even greater distances from the joint surface than had heretofore been supposed.

Heberden's nodes are the result of a chronic disease. The changes associated with it arise gradually and they progress at a slow rate. The bone changes seem to be largely irreversible although the tumors of cyst formation and other soft tissue enlargements have been noted to decrease in size from time to time. The size of the joint and its gross appearance is no reliable indication of the bone condition as seen on the roentgenogram. Case II photographs of the hands taken sixteen months apart were indistinguishable from each other. They showed moderate enlargement of the joints in the form of a transverse ridge across the backs of the joints. Neither flexion deformity nor deviation was apparent. The first roentgenogram shows only narrowing of the joint space of the index and ring finger with one small punched out area 2 mm. in diameter. A roentgenogram sixteen months later shows only slight change from the previous one, the joint spaces being slightly smaller than before.

In Case III marked progress of the bone deformities were observed in forty-two months. At the first examination the roentgenograms showed the index finger to be nearly normal. The ring finger showed only decreased joint space. The middle finger showed no definite narrowing of the joint space with increased density of the joint surface and increased width of the joint. The little finger shows the same change. Forty-two months later the bases of the distal phalanges of the middle, ring, and little fingers have become definitely broadened. There is further narrowing of the joint spaces and increased density of bone in these fingers. Marked change in bone trabeculation with the appearance of the foamy structure of the end of the middle phalanges is now marked.

In Case II, the first posteroanterior roentgenogram shows only slight changes in the index and little fingers with narrowing of the joint space and slight condensation of bone. Roentgenograms taken again six years later show marked deformity of the joint lines, irregularity of the joint space and spur formation and broadening of the base. The same foamy change in the trabeculae is again noted.

Thus it is found that marked bone changes were seen to occur when fingers with developing Heberden's nodes but only slight bone changes were re-examined in six years and in forty-two months. On the other hand, only slight changes were

noted in Case 11 in a period of sixteen months.

SUMMARY

Heberden's nodes are enlargements of finger joints due to degenerative joint disease. Review of a series of photographs and roentgenograms reveals the following noteworthy features of Heberden's nodes.

1. Their appearance may range widely from Heberden's original description of "hard knobs about the size of a small pea."

2. They may start as a fluctuant swelling, a myxomatous subcutaneous cyst or a synovial lesion in the skin but develop from these to large bony deformities.

3. Roentgenograms reveal enlargement of the ends of the bones with distortion of joint space and irregularity of the joint surface. Large spurs develop from the attachments of the flexor and the extensor tendons to the terminal phalanx. Such spurs seen only in lateral views have been heretofore largely overlooked.

4. The distal ends of the middle phalanges undergo marked change of the bony structure with irregularity and a foamy arrangement of the trabeculae.

5. Heberden's nodes, typical manifestations of degenerative joint disease of the terminal finger joints, are sometimes associated with degenerative joint disease of the proximal interphalangeal joints. Such association was noted in 40 per cent of our cases.

6. Degenerative joint disease involves periarticular soft tissue, tendinous attachments and subchondral marrow spaces as well as the joint cartilage and the immediately underlying bone.

7. The joint changes which occurred during definite periods of time have been described.

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REFERENCES

1. Heberden, W. Commentaries on the History and Cure of Diseases. Second edition. T. Payne, London, 1803, p. 148.
2. Charcot, J. M. Clinical Lectures on Senile and Chronic Diseases. The New Sydenham Society, London, 1881, 307 pp.
3. Stecher, R. M. Heberden's nodes; incidence of hypertrophic arthritis of the fingers. *New England J. Med.*, 1940, *222*, 300–308.
4. Stecher, R. M. Heberden's nodes. Heredity in hypertrophic arthritis of the finger joints. *Am. J. M. Sc.*, 1941, *201*, 801–809.
5. Stecher, R. M., and Hersh, A. H. Heberden's nodes; mechanism of inheritance in hypertrophic arthritis of the fingers. *J. Clin. Investigation*, 1944, *23*, 699–704.
6. Scott, S. G. Radiological Atlas of Chronic Rheumatic Arthritis (The Hand). Oxford Medical Publications, London, 1935.
7. Stecher, R. M. Heberden's nodes; their relation to other degenerative joint disease. *Arch. Phys. Med.*, 1946, *27*, 409–413.
8. Gross, R. E. Recurring myxomatous, cutaneous cysts of the fingers and toes. *Surg., Gynec. & Obst.*, 1937, *65*, 289–302.

RIGHT PARADUODENAL HERNIA WITH ROENTGEN DIAGNOSIS AND POSTOPERATIVE RECOVERY*

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PARADUODENAL hernias consist of the enclosure of the greater part of the small bowel by the mesocolon through the duodenojejunal junction. They may be right or left sided.

There has been a difference of opinion as to the etiology of this condition with one or two theories being accepted by different investigators. In 1923 Andrews[1] discussed the two types of paraduodenal hernia and described their formation as a congenital anomaly of the development of the peritoneum. In the normal formation of the colon the cecum progresses in a counter clockwise direction from the area of the splenic flexure across the abdomen forming the transverse colon to the hepatic flexure and then downward into the right lower quadrant. Should the cecum proceed more directly into the right lower quadrant it would not lie superior to the small intestine. Then as it lengthened, the small bowel would be caught in the mesentery and enveloped[12] when the mesentery became attached to the right posterior abdominal wall (Fig. 1). According to Andrews[1] this would be the means of formation of a right paraduodenal hernia. The left-sided hernia originates by a similar process. If no rotation should occur, the cecum would lie to the right of the midline in the lower abdomen. Then as it elongates the small bowel would become enveloped in the mesentery of the descending colon. It would therefore lie to the left of the midline with the opening facing to the right (Fig. 1).

The second theory is that advanced by Treitz.[22] It was his contention that on occasion a loop of small intestine could project itself into the duodenojejunal junction and that due to changes in the intra-abdominal pressure a retroperitoneal hernia would result. There have been cases reported that seem to support both theories, with more emphasis being given to that of embryological maldevelopment.

Anatomically, the two types of paraduodenal hernia may be differentiated by the following criteria:

Right	*Left*
1. The sac occupies the right half of the abdominal cavity and lies between the ascending and transverse mesocolon.	1. The sac occupies the left half of the abdominal cavity and lies between the descending and transverse mesocolon.
2. The opening of the sac is on the left side and opens toward the left.	2. The opening of the sac is on the right side and opens toward the right.
3. The superior mesenteric artery (or ileocolic artery) lies in the anterior sac wall.	3. The inferior mesenteric artery lies in the anterior sac wall.

Left-sided paraduodenal hernia has been found to occur more frequently than right-sided, with about three times as many reported in the medical literature.

A summary of the literature shows that there have been 51 cases of right paraduodenal hernia reported. These include those diagnosed by all means, i.e., at operation, roentgenologically and postmortem. Of those reported only 19 have recovered with 32 operated upon. The age of the patients who recovered from operation varies from twelve to fifty-six years with the greatest number falling between twenty-five to fifty. Eleven out of the 19 were males.

There appears to be slight confusion in the literature as to the number of cases of right paraduodenal hernia reported. Cogswell and Thomas,[7] and Hodges,[14] in separate reports refer to their cases as the sixteenth with recovery. In Table 1, we have attempted to put the various cases reported with postoperative recovery in their correct chronological order.

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TABLE I

REPORTED CASES OF RIGHT PARADUODENAL HERNIA WITH POSTOPERATIVE RECOVERY

Case No.	Author	Age of Patient yr.	Sex	How Diagnosed	Roentgen Examination
1	Neuman[19]	55	F	Operation	None
2	Carson[6]	29	M	Operation	None
3	Brown[4]	49	M	Operation	Reported negative
4	Lower and Higgins[17]	12	F	Operation	None
5	Deaver and Burden[8]	25	M	Operation	None
6	Flechtenmacher[11]	38	M	Operation	None
7	Taylor[21]	32	M	Operation	Encapsulated appearance of small bowel as if sac enclosed
8	Taylor[21]	24	M	X-ray	Encapsulated appearance of small intestine
9	Masson and McIndoe[18]	41	M	Operation	Reported negative
10	Dowdle[9]	24	M	Operation	None
11	Exner[10]	56	F	X-ray	Encapsulated appearance of small bowel; displacement of colon; greatly dilated terminal ileum (oral barium and barium enema)
12	Halliwell[13]	35	M	Operation	Dilated coils of small intestine bunched together chiefly on the right side of the abdomen
13	Bryan[5]	18	F	Operation	None
14	Averbach[2]	14	M	Operation	None
15	Baumeister and Hanchett[3]	21	F	Operation	None
16	Cogswell and Thomas[7]	49	F	Operation	Dilated loops of small bowel and ptosis of transverse colon (barium enema)
17	Hodges[14]	22	M	Operation	None
18	Lahey and Trevor[16]	47	M	Operation	Postoperative review showed spherical encapsulation of small intestine as though contained in paper bag
19	Lahey and Trevor[16]	17	F	Operation	Reported as redundant duodenal loop. Postoperative review showed abnormal location of jejunum on right side of abdomen; absence of transverse third and ascending fourth portions of the duodenum
20	Reeves, Moran and Jones	28	M	X-ray	Encapsulated appearance of small bowel; dilated small bowel; displacement of colon (oral barium)

Klob[15] reported the first case of right paraduodenal hernia in 1861, and Neuman[19] the first with successful operation. Reviewing all the cases we were able to find only 9 that had roentgenological studies of the gastrointestinal tract. One was a study of the large bowel[7] which showed a low transverse colon and dilated loops of small bowel. Two[4,18] reported roentgen studies as negative. The remaining 6 cases showed findings that can be considered good presumptive evidence of right paraduodenal hernia. However, only 2 cases have been correctly diagnosed preoperatively. Taylor[21] has received due recognition for the first case of right paraduodenal hernia diagnosed preoperatively. Exner[10] in 1933 reported the second. Both were verified by operation.

CASE REPORT

CASE 1. A twenty-eight year old colored man was admitted to the Medical Service of Duke

Hospital with the complaint of several attacks of abdominal pain over a period of two months. The initial onset of the abdominal pain followed the ingestion of peanuts and an iced drink. This attack was characterized by a sudden, sharp pain in the periumbilical region which gradually became cramping in character and

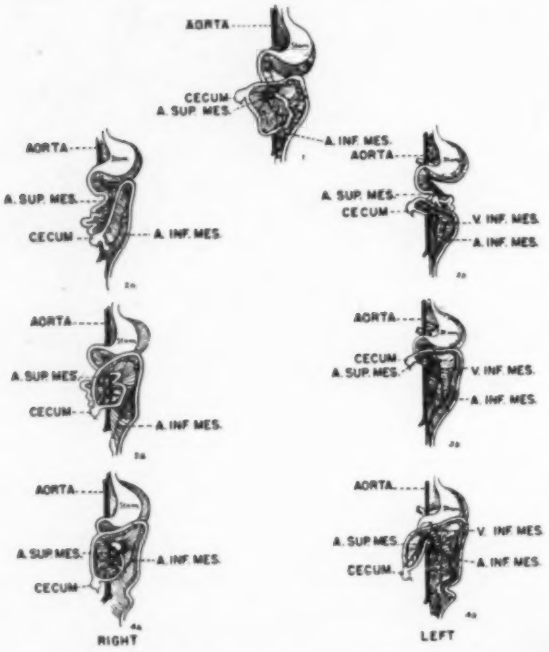

FIG. 1. (Modified from Andrews[1] by special permission of *Surgery, Gynecology and Obstetrics*.) *1*, normal rotation of the cecum and small bowel. *2a*, *3a*, *4a*, the cecum proceeds more directly into the right lower quadrant. As the small bowel lengthens it is enveloped by the mesentery, forming a right paraduodenal hernia. *2b*, *3b*, *4b*, when no rotation occurs the elongation of the small bowel causes it to be enveloped by the mesentery of the descending colon. A left paraduodenal hernia is thus formed.

more severe. He vomited food eaten that day without evidence of blood. The initial attack lasted eight hours and was relieved in part by a hypodermic and an enema.

After the onset the patient had five similar attacks which were treated by hypodermics, gastric lavage, and enemas. No history of digestive disturbances between attacks could be obtained.

The family and marital history were noncontributory.

Past history revealed patient's general health to be good. There was a history of inadequately treated syphilis.

Physical examination: temperature, 37°C.; pulse, 78; respiration, 18; blood pressure, 110/50. The patient was a moderately welf developed and well nourished colored man ol approximately stated age. The pertinent physical findings were as follows: small, generalized lymphadenopathy; heart enlarged to the left; protodiastolic murmur loudest in third left interspace. The abdomen was flat without masses or palpable organs.

Laboratory findings showed a normal blood study with two negative blood Wassermann tests. Spinal fluid studies were negative.

Roentgen examination showed the stomach and duodenal bulb to be normal. "There is a peculiar, apparently anatomical disarrangement of the jejunum and upper ileum in that these two sections of the bowel assume an almost perfectly spherical shape in configuration. The small intestinal pattern is perfectly normal, but the intestines have the appearance of being enclosed in a round sac-like structure" (Fig. 2). A diagnosis of malrotation or herniation of the small intestine was made and the former ruled out by the normal position of the cecum and terminal ileum (Fig. 3). A preliminary diagnosis of right paraduodenal hernia was

FIG. 2. Case 1. Roentgenogram clearly demonstrates (1) sac enclosed appearance of small intestine; (2) loss of continuity of the normal loop of duodenum. The major portion of the small intestine lies to the right of the midline.

made and the patient transferred to the surgical service.

At operation a large retroperitoneal hernia of about two-thirds of the small intestine was found. The entrance to the sac was in the region of the ligament of Treitz through the duodenojejunal junction. The preoperative diagnosis of right paraduodenal hernia was confirmed. The sac was obliterated with interrupted silk sutures and the small intestine returned to its normal position. The patient withstood the operation well and was returned to the ward in good condition.

Postoperative course was uneventful, and there were no further attacks of abdominal pain. A subsequent study of the gastrointestinal tract showed no abnormality in the position of the small bowel (Fig. 4).

That herniation of the small bowel can be present without causing symptoms is seen from the numerous cases that have been found in cadavers and on autopsy examination of patients who died from other causes with no history of abdominal symptoms. In those patients requiring operation the symptoms have varied from recurrent right lower quadrant pain to those of complete or partial intestinal obstruction.

Fig. 3. Case 1. Six hour roentgenogram shows the cecum and terminal ileum in their normal positions. There appears to be displacement of the ascending and transverse portions of the colon by the retroperitoneal hernia. There is gaseous dilatation of the small bowel.

Fig. 4. Case 1. Re-examination of the gastrointestinal tract three weeks after operation shows the small intestine to be restored to normal position.

The technique of examining patients by the routine barium meal studies should suffice for the diagnosis of paraduodenal hernia, if that routine includes roentgenoscopy of the duodenum and small bowel in the upright and prone positions, as it does in this clinic. If the condition is suspected, interval films from one to six hours and at twenty-four hours, with lateral views, should be included. Small bowel studies are essential for the diagnosis. In those cases in which it is feasible to carry out a diagnostic procedure such as this, certain findings strongly indicate the diagnosis of duodenal hernia. The condition with which it might be most frequently confused is malrotation, but barium enema with study of the position of the cecum and terminal ileum will usually serve to differentiate the two.

When the condition of the patient makes the administration of oral barium and manipulation unwise, then a preliminary

roentgenogram of the abdomen and differential diagnosis would be necessary. A definite diagnosis of paraduodenal hernia cannot be made under these conditions.

In the cases reported as diagnosed preoperatively and in the cases with roentgen studies but not diagnosed before operation, the position of the small bowel appeared typical. The coils of small intestine lay in a spherical, well defined area as though enclosed in a sac. During study with oral barium the third and fourth portions of the duodenum showed obliteration.

Usually the coils of intestine cannot be separated by palpation and pressure. In the prone position the loops of bowel remain encapsulated and do not show normal downward gravitation into the pelvis. There is displacement or distortion of the stomach and/or colon. The immobility of the herniated bowel frequently results in distention by gas, but this may be found in other types of partial or complete intestinal obstruction.

SUMMARY

Although only two cases of right paraduodenal hernia have been previously diagnosed preoperatively, the diagnosis can be made in the majority of cases by roentgen study if the observer is familiar with the features of this condition.

Review of the literature shows almost typical findings in the cases studied. The criteria for diagnosis and theories of their formation are described.

A case of right paraduodenal hernia is presented which was diagnosed preoperatively and successfully operated upon.

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REFERENCES

1. ANDREWS, E. Duodenal hernia—a misnomer. *Surg., Gynec. & Obst.*, 1923, *37*, 740–750.
2. AVERBACH, B. F. Right paraduodenal hernia. *Am. J. Surg.*, 1937, *35*, 128–130.
3. BAUMEISTER, C., and HANCHETT, M. Right paraduodenal hernia; a case favoring the theory of Treitz. *Arch. Surg.*, 1938, *37*, 327–332.
4. BROWN, F. R. Right duodenal hernia; a case successfully operated on, fourth recorded recovery. *Brit. J. Surg.*, 1925, *13*, 367–376.
5. BRYAN, R. C. Right paraduodenal hernia. *Am. J. Surg.*, 1935, *28*, 703–730.
6. CARSON, H. W. A case of right duodenal hernia. *Proc. Roy. Soc. Med., Surg. Sec.*, 1912, *5*, 214–216.
7. COGSWELL, H. D., and THOMAS, C. A. Right paraduodenal hernia. *Ann. Surg.*, 1941, *114*, 1035–1041.
8. DEAVER, J. B., and BURDEN, V. G. Right paraduodenal hernia. *Surg. Clin. North America*, 1929, *9*, 1015–1016.
9. DOWDLE, E. Right paraduodenal hernia. *Surg., Gynec. & Obst.*, 1932, *54*, 246–250.
10. EXNER, F. B. Roentgen diagnosis of right paraduodenal hernia. AM. J. ROENTGENOL. & RAD. THERAPY, 1933, *29*, 585–599.
11. FLECHTENMACHER, C. Hernia retroperitonealis mesenterica mit Einklemmung des gesamten Dünndarmes, Resektion des Bruchsackes, Heilung. *Zentralbl. f. Chir.*, 1929, *56*, 1284–1286.
12. GARDNER, C. E., JR., and HART, D. Anomalies of intestinal rotation as a cause of intestinal obstruction. *Arch. Surg.*, 1934, *29*, 942–981.
13. HALLIWELL, A. C. Right paraduodenal hernia. *Brit. J. Surg.*, 1934, *21*, 398–403.
14. HODGES, G. C. Case of right paraduodenal hernia; sixteenth recorded case of recovery after operation. *Roy. Melbourne Hosp. Clin. Rep.*, 1941, *12*, 35–38.
15. KLOB. Hernia retroperitonealis. *Wchnschr. d. Aertz in Wien*, 1861, V. 24.
16. LAHEY, F. H., and TREVOR, W. Right paraduodenal hernia. *Ann. Surg.*, 1945, *122*, 436–443.
17. LOWER, W. E., and HIGGINS, C. C. Retroperitoneal hernia. *Ann. Surg.*, 1925, *82*, 576–583; also in, *Tr. Am. Surg. Ass.*, 1925, *43*, 586.
18. MASSON, J. C., and MCINDOE, A. H. Right paraduodenal hernia and isolated hyperplastic tuberculous obstruction. *Surg., Gynec. & Obst.*, 1930, *50*, 29–39.
19. NEUMAN, A. Ein Fall von operativ geheilter Hernia retroperitonealis mesenterico-parietalis. *Deutsche Ztschr. f. Chir.*, 1898, *47*, 476–491.
20. NOVAK, E., and SUSSMAN, A. A. Right paraduodenal hernia. *J.A.M.A.*, 1924, *82*, 1664–1667.
21. TAYLOR, J. The x-ray diagnosis of right paraduodenal hernia. *Brit. J. Surg.*, 1930, *17*, 639–640.
22. TREITZ. Hernia retroperitonealis, ein Beitrag zur Geschichte innerer Hernien. Prague, 1857.

DUODENAL DIVERTICULA WITH ULCERATION*

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FOR two hundred years after Chomel[1,5] made the first report of a duodenal diverticulum there were few reports of this condition, all on autopsy findings, and in 1911 less than one hundred cases were on record.[13] In 1913 Case[10] reported 4 cases of duodenal diverticula diagnosed by roentgen examination and in 1920 he reported 85 such cases. In 1942 Finney[12] reviewed more than one hundred articles on duodenal diverticula published in the preceding ten years.

The cause of duodenal diverticula has been discussed by many writers. The sacs or pouches developed secondary to ulcer are false diverticula and properly are not considered in this paper. Diverticula have been classed as congenital when the walls contain all the layers of the intestine, and as acquired when lacking all or part of the muscle layer. It seems probable that in some cases at least a congenital defect or weakness in the muscle layer may allow the protrusion of a small pouch of mucosa, and with the enlargement of this pouch the muscle layer becomes thinned out or disappears.[12] It is significant that duodenal diverticula are found rarely in individuals under thirty years of age and that the incidence increases with age.[2]

Duodenal diverticula may be missed on roentgen examination and may not be found on surgical exploration;[3,4] unless a special search is made a diverticulum may be overlooked at autopsy. There is a great variation in the frequency reported by various authors (Tables IA and IB) ranging from 3 per cent to 22 per cent on autopsies and from 1.2 per cent to 5.3 per cent on gastrointestinal roentgen examinations.

In the past five years I and my assistants have found only 18 cases of duodenal diverticulosis in 5,712 gastrointestinal roentgen examinations. This low incidence of about

TABLE IA*

PERCENTAGE-FREQUENCY OF DUODENAL DIVERTICULA FOUND AT AUTOPSIES AND AT ROENTGENOLOGIC EXAMINATIONS

Author	Year	Number of Autopsies	Number of X-Ray Examinations	Duodena with Diverticula	Percentage
Schuppel	1880	45		7	15.5
Rosenthal	1908	100		3	3.0
Baldwin	1911	105		14	13.3
Linsmayer	1914	1,367		45	3.3
Horton and Mueller	1933	216		11	5.09
Grant	1935	133		15	11.3
Case	1920		6,847	85	1.2
Andrews	1921		2,200	26	3.18
Spriggs and Marxer	1926		1,000	38	3.8
Cryderman	1927		770	40	5.19
Lemmel	1934		3,324	50	1.5
Rankin and Martin	1934		72,715	111	0.016
Edwards	1939		11,362	85	0.75

* From Ackermann.[1]

* The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

TABLE IB

FREQUENCY OF DUODENAL DIVERTICULA

Author	Year	Number of Autopsies	Number of X-Ray Examinations	Duodena with Diverticula	Percentage
Gibbon[13]	1933		1,978	20	1.05
Edwards[11]	1935		3,931	31	0.78
Lawson[22]	1935		2,250	36	1.6
Beals[2]	1937		1,887	41	2.2
Browne and McHardy[5]	1943		789	42	5.3
Ackermann[1]	1943	50		11	22.0

0.32 per cent may be due in part to the inexperience of some of the examiners, but more probably the main factor is the low average age, as most of our patients were in active naval service and a very high percentage of these were below thirty years of age.

Duodenal diverticula are rare in infancy[22] and youth, not common in the middle decades, but found in a considerable percentage of individuals in the upper age groups; the average age in reported series of cases has been over fifty years (Table II). Our 18 cases ranged from seventeen to sixty-nine years of age, with an average of 38.5 years.

Very few true diverticula have been found in the first part of the duodenum; about 65 per cent of all reported cases have been in the second part, and about 30 per cent in the third and fourth parts (Table III). In 18 cases we found ten diverticula in the second part, six in the third part and two in the fourth part.

When duodenal diverticula are not pressing on other organs or causing obstruction to the biliary tract they may produce no symptoms. In some cases there are complaints of vague upper abdominal pain, occasionally cramps, nausea or other digestive tract disturbances for which no cause, other than the diverticulum, may be found. If, after careful and repeated search for other pathology, no other cause is found, the diverticulum must be considered as producing symptoms. Conversely if no cause for gastrointestinal symptoms is found on routine examinations, a careful search for a diverticulum should be made. When there are complications the symptoms are more pronounced and severe. If a diverticulum is found and there is

TABLE II

AGE DISTRIBUTION OF DUODENAL DIVERTICULA

Author	Number of Cases	Average Age
Beals[2]	34	53.3 years
Browne and McHardy[5]	42	55% over 50
Case[10]	85	56
Edwards[11]	31	51.9
Finney[12]	19	63.7
Gibbon[13]	20	52
Lawson[22]	36	51.4
Weintraub and Tuggle[37]	310	60.3% over 50

TABLE III

LOCATION OF DUODENAL DIVERTICULA

Author	1st Part	2nd Part	3rd and 4th Parts
Ackermann[1]	0	6	8
Beals[2]	0	28	17
Browne and McHardy[5]	3	29	13
Case[10]	17	49	19
Edwards[11]	0	22	9
Gibbon[13]	1	12	8
Lawson[22]	8	16	12
Weintraub and Tuggle[37]	6	248	95
Totals	35	410	181
Per cent	5.6	65.4	29

localized tenderness, the probability of diverticulitis or ulcer must be considered. When there is hemorrhage from the upper part of the gastrointestinal tract and a diverticulum is found, with no other cause for the bleeding, ulceration in the diverticulum is a reasonable conclusion.

Diverticulitis and ulceration in duodenal diverticula have been the subject of few reports, but it seems probable that some of the cases of duodenal diverticulosis with persistent symptoms may have ulceration in the diverticula. Browne and McHardy[5] had 3 cases of diverticulitis in 42 cases of diverticulosis of the duodenum. Finney[13] had 19 cases with duodenal diverticula in 2 of which there was hemorrhage for which no other cause could be found. Lahey[21] had 2 cases of hemorrhage from duodenal diverticula; in one the bleeding spot was found in the excised diverticulum, and the pathological report was atypical gastric mucosa. Huddy[18] reported a case of duodenal diverticulitis with gangrene; I have found six reports of perforated duodenal diverticula (Table IV) and there are probably other cases not reported or overlooked in my review of the literature. In our 18 cases there were 2 with severe and repeated hemorrhage; hemorrhage as well as perforation must be considered as due to ulceration.

Complications other than ulcer and inflammation have been reported; Ogilvie[32] had 4 cases of perivaterine diverticula, 1 causing obstruction of the bile duct and 3 associated with acute pancreatitis. Chomel[5] reported a calculus in a duodenal diverticulum, and Rankin[34] a 2 inch gallstone in a duodenal diverticulum. Neoplasms in duodenal diverticula are very rare; Mendillo and Koufman[26] report a diverticulum with sarcoma of the duodenum; Morrison and Feldman[30] report 1 case of primary carcinoma in a duodenal diverticulum; Hodges[17] describes a case of adenocarcinoma arising from the mucosa of a duodenal diverticulum which was buried in the head of the pancreas. I had 1 case similar to that of Hodges,' a diverticulum of the second part of the duodenum extending into the pancreas; carcinoma was suggested on account of the irregular contour of the diverticulum, and this was confirmed at autopsy. Unfortunately the films and records were left in the Naval Hospital, Canacao, P. I.

TABLE IV

DUODENAL DIVERTICULA WITH COMPLICATIONS

Author	Cases Reported	Number with Diverticulitis	Number with Ulcer	Number with Perforation	Number with Hemorrhage
Beaver[3]	1			1	
Boland[4]	1			1	
Browne and McHardy[5]	42	3			
Finney[12]	12				2
Hahn[15]				2	
Huddy[18]	1	1			
Lahey[21]			1		2
Lucinian[23]	1			1	
Monsarrat[27]	1			1	

The question of treatment of duodenal diverticula is one that must be decided for the individual patient. When the symptoms are not too severe and do not indicate the need for immediate surgery, diet and antispasmodics, or a modified ulcer regimen, should be continued for a long time and all other possible causes of the symptoms considered before surgery is advised. The operation for duodenal diverticulum is not a minor procedure and most of these pa-

Fig. 1. Case 1. Oblique projection showing diverticulum of fourth part of duodenum.

tients are not good surgical risks; the mere presence of a diverticulum is not an indication for surgery.[12] A careful clinical evaluation of the severity of the symptoms, the age and condition of the patient and the surgical procedures required must be made before surgery is advised. When there is biliary or intestinal obstruction, or perforation, the diagnosis of diverticulum is usually not made before operation. When there are severe and persistent symptoms not relieved by prolonged medical treatment, or when there is repeated hemorrhage, operation should be advised unless contraindicated by the condition of the patient.

Two of our cases had a history of repeated hemorrhage; surgery was advised and one case submitted to operation.

CASE REPORTS

Case 1. I. F. W., white male, aged forty-nine; admitted January 16, 1941, complaining of extreme weakness, nausea and dizziness. Previously the patient had not been seriously ill except for appendicitis in 1920, and after the appendectomy he continued in good health. For several years he had noticed that his abdomen seemed to swell after meals, and that he was uncomfortable after a large meal; he belched considerably and had noticed some shortness of breath. On January 12, after a few drinks, the patient felt nauseated and vomited; he returned to his ship and there vomited several times, the vomitus containing fresh blood and blood clots. The following day he noticed that his stools were black and tarry; stools have continued tarry since then. The night of January 15, while the patient was in a movie show he became nauseated and dizzy; he went to a nearby hotel and went to bed, said that he felt too weak to move for some time, but later telephoned for an ambulance; he was admitted after midnight. There was rather marked pallor, a pulse rate of 100, and slight tenderness over the left upper abdomen; physical examination otherwise was essentially negative. He was found to be slightly anemic; the stools were tarry during the first week in the hospital, and occult blood tests were positive for three weeks; routine laboratory studies otherwise were within normal limits. The patient was kept in bed on

Fig. 2. Case 1. Six hour residue in diverticulum.

Sippy regimen for ten days; there was no recurrence of vomiting or gross bleeding.

On January 29, 1941, gastrointestinal roentgen examination showed the esophagus, stomach, and upper duodenum to be normal. There was a diverticulum about 5 cm. in diameter extending from the anterolateral border of the fourth part of the duodenum just proximal to the duodenojejunal flexure. There was some irregularity in filling of the diverticulum (Fig. 1) possibly due to blood clot. Two small jejunal diverticula were noted and also a ring-shaped calcium deposit near the left kidney (aneurysm of the renal artery?). At six hours there was a barium residue in the diverticulum with a streaky density.

The patient did not desire operation and was returned to duty. He was re-examined in February and again in December, 1941; the diverticulum then filled with even density. No cause for bleeding other than the diverticulum was found. There had been no recurrence of bleeding at the time of the last examination, but the patient still complained of shortness of breath and a feeling of over-distention after meals.

Case II. W. B. T., white male, aged thirty-three, was referred for gastrointestinal roentgen examination on June 5, 1944. He stated that he had had stomach trouble "all of his life," characterized by attacks of acute abdominal pain, cramps and nausea, frequently with vomiting. Vomiting usually relieved the acute attacks which occurred at intervals of from a few days to several months; the patient never felt entirely well between attacks but always had a feeling of abdominal discomfort and sometimes had "heartburn." Soda gave some relief but milk and other foods had little effect. The patient avoided large meals and fried foods as he had been advised to do so. He had consulted many physicians and had been given various treatments. In 1929 he had been operated on for acute appendicitis; this did not change the character of his symptoms. In 1936, twenty-four hours after a large dose of magnesium sulphate, given to stimulate gallbladder drainage, the patient had a severe hemorrhage; he vomited bright blood and passed changed blood per rectum. Since 1936 he has had several small hemorrhages, one of which followed passage of a duodenal tube. He has had six roentgen examinations of the gastrointestinal tract and gallbladder. One observer reported chronic

Fig. 3. Case II. Diverticulum of third part of duodenum.

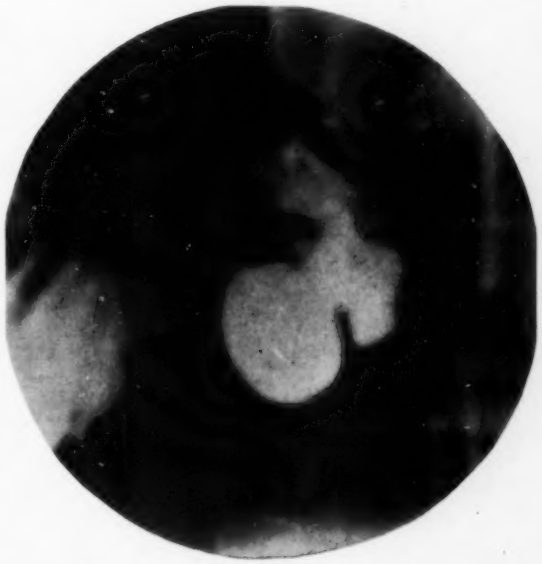

Fig. 4. Case II. Pressure spot film showing detail of diverticulum. Note appearance of niche.

cholecystitis, the other reports were negative. A competent surgeon refused to operate on the grounds that the history and symptoms were not those of gallbladder disease.

Gastrointestinal roentgen examination showed no abnormalities in the esophagus, stomach or upper duodenum. There was a diverticulum, about 3.5 by 2 cm., extending below the inferior margin of the duodenum at

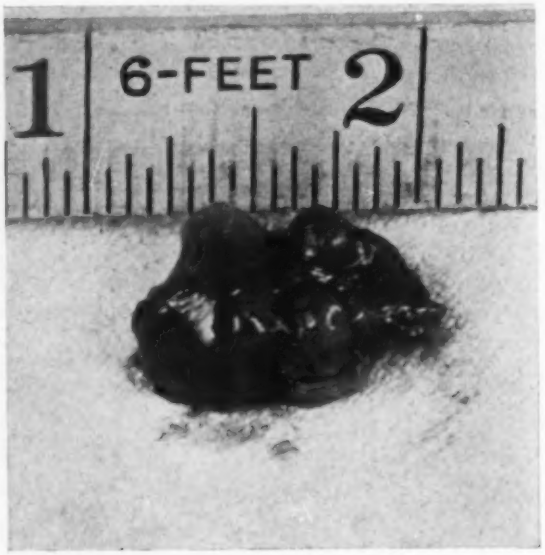

Fig. 5. Case II. Excised diverticulum.

about the junction of the third and fourth parts, apparently arising near the mesentery. There was a narrow neck to the diverticulum and just below the neck on the right side there was a small niche (Fig. 4) and there was a contracture of the inferior wall so that the sac appeared to be lobulated. There was definite localized tenderness on pressure over the diverticulum. A report was made of a duodenal diverticulum with a niche indicating ulcer.

On June 12, 1944, patient admitted to hospital. Physical examination was essentially negative except for slight epigastric tenderness; all routine laboratory tests were within normal limits. The patient appeared depressed, and apprehensive; he was willing to submit to operation but seemed doubtful of being benefited; his general attitude was that of a neurotic individual.

On June 15 cholecystography showed a normally functioning gallbladder without calculi.

On June 19, operation by Commander J. D. Pessagno (M.C.) U.S.N.R.: "Upper right rectus incision, the fossa of Treitz was exposed and the ligament divided. About 8 cm. proximal to the duodenojejunal junction a diverticulum was found on the posterolateral surface of the inferior border of the duodenum. It was firmly adherent to the surrounding tissue and was freed by blunt dissection. Because of the narrow neck the diverticulum was excised without difficulty, and the duodenum was closed with two rows of silk sutures. The abdomen was closed in the usual manner."

The postoperative course was not unusual; fluids were given by mouth on the second day, soft diet started on the sixth postoperative day and full regular diet on the fourteenth day.

Pathological report, by Lieutenant Commander H. C. Allen (M.C.) U.S.N.R.: "Specimen is a diverticulum of the intestinal tract about 2 by 1.5 by 1.0 cm.; attached to the outside is a very small lymph node; in the central part of the diverticulum is an area where the epithelium is missing, covered with a blood clot (operative trauma?). Microscopic examination shows that the wall is made up of two distinct layers of muscle which are thin in some areas. The epithelium is papillary in type and the cells are tall and columnar with nuclei at the base; numerous cells contain secretory droplets; no Brunner's glands are present. The epithelium is a little thinned out in one area, but there are no fibrosis and no definite ulceration. There is a considerable number of lymphocytes and eosinophils at the base of the epithelium and some scattered among the muscle fibers. Diagnosis: congential diverticulum of the small intestine."

The diverticulum, at operation, was clamped across the neck, and the small niche (Fig. 4) may have been crushed by the clamp or included in the line of excision. This niche could not be identified in the gross specimen; the contracture on the inferior wall was due to a band of adhesions.

July 24, re-examination of the gastrointestinal tract showed slight initial pylorospasm; there was very slight narrowing of the duodenum at the site of operation; there was normal progress of the meal at three and six hours. The patient felt much improved, but still had some abdominal discomfort; he said that he had had stomach ache so long that he "couldn't get his stomach off his mind." After the usual

convalescent leave, the patient returned to duty.

March 17, 1945, patient returned for check up; since operation he had had no acute abdominal pain, he has gained weight and feels well. He has had periods of abdominal discomfort, but this has only occurred when he was tired or worried. Roentgen examination of the gastrointestinal tract showed no evidence of pathology.

October 17, 1945, patient reports that he fells entirely well, with no recurrence of symptoms.

SUMMARY

Duodenal diverticula occur in certain individuals and are probably congenital or due to congenital defects in the intestinal wall; the incidence increases with age in reported series of examinations. Most duodenal diverticula cause no symptoms or only vague discomfort, but in some cases there are severe symptoms due to pressure on other organs or to complications. Ulceration may occur in the diverticulum, which may or may not contain atypical gastric mucosa; hemorrhage from a diverticulum is most probably due to ulceration. Pain and localized tenderness may be due to ulcer or diverticulitis.

In our 18 cases 16 had no symptoms that were considered as due to the diverticulum. One case had a gross hemorrhage repeated within a few days. One case had symptoms from childhood, and repeated hemorrhages over a period of eight years; excision of the diverticulum relieved the symptoms and there has been no recurrence in eighteen months.

ADDENDUM

I have reviewed a series of 645 gastrointestinal examinations made since my return to civilian practice; these cases were in an older age group than those covered by this paper, ranging from infancy to ninety-two years of age. There were 25 cases (3.88 per cent) with duodenal diverticulosis, with an average age of 55.8 years; the youngest was twenty-nine, and the oldest eighty-two. Five of these cases had definite symptoms for which no cause other than the diverticulum was found; one of these cases had a history of bleeding.

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REFERENCES

1. Ackermann, W. Diverticula and variations of the duodenum. *Ann. Surg.*, 1943, *117*, 403–413.
2. Beals, J. A. Duodenal diverticula. *South. M. J.*, 1937, *30*, 218–222.
3. Beaver, J. L. Acute perforation of duodenal diverticulum. *Ann. Surg.*, 1938, *108*, 153–154.
4. Boland, F. K., Jr. Acute perforated duodenal diverticulum. *Surgery*, 1939, *6*, 65–67
5. Browne, D. C., and McHardy, G. Duodenal diverticulitis, acute and chronic. *New Orleans M. & S. J.*, 1943, *95*, 553–558.
6. Buckstein, J. Duodenogram applied to demonstration of duodenojejunal diverticulum. *Am. J. Surg.*, 1927, *3*, 340–341.
7. Buckstein, J. Clinical Roentgenology of the Alimentary Tract. W. B. Saunders Co., Philadelphia, 1940, p. 296.
8. Buckstein, J. Personal communication.
9. Case, J. T. Roentgen observations on the duodenum with special reference to lesions beyond the first portion. Am. J. Roentgenol., 1916, *3*, 314–326.
10. Case, J. T. Diverticula of small intestine, other than Meckel's diverticulum. *J.A.M.A.*, 1920, *75*, 1463–1469.
11. Edwards, H. C. Diverticula of duodenum. *Surg., Gynec. & Obst.*, 1935, *60*, 946–965.
12. Finney, J. M. T., Jr. Duodenal diverticula; their significance and treatment. *South. Surgeon*, 1942, *11*, 543–554.
13. Gibbon, W. H. Diverticula of duodenum. *Radiology*, 1933, *21* 491–494.
14. Guthrie, D., and Brown, M. J. Diverticula of proximal intestine: duodenum and jejunum. *Am. J. Surg.*, 1938, *40*, 128–139.
15. Hahn, O. Das Duodenaldivertikel. *Ergebn. d. Chir. u. Orthop.*, 1930, *23*, 351–405. Quoted by Boland.[4]
16. Hatchette, S. Multiple diverticula of jejunum, duodenum and colon. *Radiology*, 1940, *34*, 577–580.
17. Hodges, F. J. Gastrointestinal Tract. Year Book Publishers, Inc., Chicago, 1944, pp. 82–83.
18. Huddy, G. P. B. Duodenal diverticula with report of a case of gangrenous diverticulitis. *Lancet*, 1923, *2*, 327. Quoted by Beaver.[3]
19. Kellogg, E. L. The Duodenum. Paul B. Hoeber, Inc., New York, 1933, pp. 221–239.
20. Lahey, F. H. Surgery of duodenum. *New England J. Med.*, 1940, *222*, 444–451.
21. Lahey, F. H. Personal communication.
22. Lawson, J. D. Duodenal diverticulosis. Am. J. Roentgenol. & Rad. Therapy, 1935, *34*, 610–616.
23. Lucinian, J. H. Diverticulum of duodenum perforated into the pancreas. Am. J. Roentgenol. & Rad. Therapy, 1930, *24*, 684–685.

24. Lust, F. J. Multiple diverticula of first part of duodenum. *Radiology*, 1937, *28*, 620–621.
25. Maclean, M. J. Diverticulum of duodenum. *Surg., Gynec. & Obst.*, 1923, *37*, 6–13.
26. Mendillo, A. J., and Koufman, W. B. Diverticulum and sarcoma of the duodenum. *New England J. Med.*, 1938, *219*, 432–433.
27. Monsarrat, K. W. Acute perforation of duodenal diverticulum. *Brit. J. Surg.*, 1926–1927, *14*, 179–180.
28. Moore, E. C. Lewis, Practice of Surgery. W. F. Prior Co. Hagerstown, Md., 1944, Vol. VI, Chap. 13.
29. Morrison, T. H., and Feldman, M. Carcinoma in duodenal diverticulum with consideration of duodenal diverticulosis. *Ann. Clin. Med.*, 1925, *4*, 403–414.
30. Morrison, T. H., and Feldman, M. Autopsy report of a case of primary carcinoma in a duodenal diverticulum. *Ann. Clin. Med.* 1926, *5*, 326–329.
31. Morton, J. J. Surgical treatment of primary duodenal diverticula. *Surgery*, 1940, *8*, 265–274.
32. Ogilvie, R. F. Duodenal diverticula and their complications with particular reference to acute pancreatic necrosis. *Brit. J. Surg.*, 1941, *28*, 362–379.
33. Pendergrass, R. C. Duodenal diverticula, with report of two cases. *Am. J. Surg.*, 1928, *5*, 491–497.
34. Rankin, L. M. Diverticula of duodenum. Am. J. Roentgenol. & Rad. Therapy, 1942, *47*, 585–587.
35. Tanner, W. E., and Benians, T. H. C. Congenital duodenal diverticulum. *Lancet*, 1939, *2*, 1117–1118.
36. Thorek, M. Duodenal diverticula with ulcer. *Illinois M. J.*, 1929, *55*, 64–68.
37. Weintraub, S., and Tuggle, A. Duodenal diverticula. *Radiology*, 1941, *36*, 297–301.

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A PATHOGNOMONIC ROENTGEN SIGN OF RETROPERITONEAL ABSCESS*

REPORT OF TWO CASES OF RUPTURED APPENDIX WITH POSITIVE ROENTGEN FINDINGS

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IN RECENT months we have had two cases of retroperitoneal abscess caused by gas-producing organisms, giving the pathognomonic roentgen sign of multiple small radiolucent shadows representing interstitial emphysema in the retroperitoneal tissues. In both cases, the source of infection was a ruptured retroperitoneal appendix. In one case we failed to make the diagnosis at the time of the initial study, because the gas bubbles appeared to be within the confines of the bowel. The history and clinical findings are important in that they should suggest a careful search for this infrequent and perhaps obscure finding. We consider stereoscopic roentgenograms of the abdomen and single views with the patient rotated to be helpful in making apparent the extraperitoneal location of the gas.

It occurred to us that this rather typical roentgen finding had been described adequately and repeatedly in the literature but a careful survey reveals only one article by Weens[2] emphasizing the characteristic sign. For this reason a report on our two cases seems warranted. Neuhof and Arnheim[1] reported 65 cases of lumbar and iliac retroperitoneal abscess and diffuse phlegmon, 12 of which were caused by retroperitoneal rupture of the appendix. The series is thoroughly worked up and critically analyzed, but no mention is made of the above roentgen sign.

The obvious large collection of gas with or without a fluid level, indicative of an abscess, needs no comment, and the better known roentgen signs of (1) loss of the psoas shadow, (2) scoliosis with convexity away from the side of disease, (3) elevation of the diaphragm with limited excursions and (4) obscuration of the extraperitoneal fat layer are unreliable and often indefinite findings.

The first case seen by us was diagnosed because stereoscopic roentgenograms revealed innumerable small gas shadows behind the distended ascending colon and above the hepatic flexure.

CASE 1. The patient, a white male, aged forty-three, was admitted to the hospital with a presumptive diagnosis of right ureteral calculus and urinary infection. He was complaining of continuous and severe abdominal pain of three days' duration; at first the pain was epigastric, then generalized, and finally localized in the right loin and right lower quadrant. He had been taking fluids and was passing gas without difficulty. The temperature was 103.4° F., the pulse 120 and the respiration 32. Examination revealed active peristalsis and the abdomen was soft except in the right upper quadrant and loin. Maximum tenderness was localized in the right loin where fullness was noted. There was a moderate leukocytosis and the urinalysis was negative. The initial roentgen examination of the abdomen (Fig. 1) made in the supine position revealed considerable distention of the entire large bowel with extraluminal radiolucent gas shadows behind the right side of the colon from the ilium to the inferior margin of the liver. The right psoas shadow was obliterated. The following day subsequent roentgenograms of the abdomen were obtained with the patient supine (Fig. 2) and erect. The extraluminal small gas shadows were more numerous and better defined and the erect films revealed two fluid levels where the small radiolucent

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FIG. 1. Case I. A group of small, radiolucent shadows is seen on the right side, at the level of the eleventh intercostal space. Stereoscopic roentgenograms localized the gas collections far posteriorly and showed many more much less obvious radiolucent shadows behind the gas-containing ascending colon and hepatic flexure. The right kidney and psoas shadows are absent.

FIG. 2. Case I. Roentgenogram taken twenty-four hours after Figure 1. An increase in the abnormal radiolucent shadows is evident, extending downward to a larger collection of gas, just within the iliac fossa. The right kidney and psoas shadows remain absent.

zones were confluent. Roentgenoscopy revealed elevation of the right leaf of the diaphragm and limitation of its excursion.

A large retroperitoneal lumbar abscess was drained surgically two days after admission. The pus was thin, light gray and of colon odor. Culture showed many coliform bacilli and anaerobic non-hemolytic stpretococci. The patient recovered, and returned three months later for an elective appendectomy.

CASE II. The patient, a well developed colored male, aged thirty-one, was ill with abdominal pain for seven days before admission. The pain was sudden in onset, at first umbilical, gradually shifting to the right lower quadrant. On the day of admission the patient took a laxative and thereafter developed severe pain and vomiting. The patient stated that his ap-

FIG. 3. Case II. This study of the unprepared abdomen shows gaseous distention of numerous loops of small bowel. The significance of many small gas shadows on the right side was not immediately appreciated, these shadows being interpreted as representing gas mixed with fecal material in the cecum and ascending colon.

pendix had ruptured nineteen years previously and was removed at that time.

On admission he was intermittently irrational and appeared dehydrated. The abdomen was tense because of distention but not rigid. Tenderness was elicited on deep palpation, diffuse, but more marked in the right lower quadrant. The temperature was 99.4°F., the pulse 100 and respiration 30. There was a moderate leukocytosis.

The initial roentgen examination (Fig. 3) showed marked distention of many loops of small bowel, and a diagnosis of obstruction was made. These roentgenograms revealed innumerable small gas shadows in the right side of the abdomen, but the significance of this finding was not immediately appreciated.

Four hours after the first film examination the abdomen was opened and the diagnosis of small bowel obstruction verified. The surgeon found an adhesive mass in the region of the cecum and lower ileum which was presumed to be the result of the operation nineteen years previously, but the appendix was not identified. An apparent volvulus of the lower ileum appeared to be relieved by severing the adhesions and the abdomen was closed. The patient remained acutely ill for the next five days and the abdomen remained distended despite attempts at decompression by the introduction of a Miller-Abbott tube.

On the fifth day a second roentgen examination of the abdomen revealed residual small bowel obstruction (Fig. 4) and innumerable extraluminal small gas shadows in the right retroperitoneal region were now quite apparent. An unqualified diagnosis of tissue emphysema due to a retroperitoneal abscess was made.

With this evidence the patient was reoperated, and a large quantity of foul-smelling thick pus was evacuated from the retroperitoneal space. A ruptured appendix was found, freed from its retrocecal position, and removed. The patient died shortly after the second operation. Postmortem examination revealed a large retroperitoneal abscess extending throughout the right lumbar and iliac area from the right leaf of the diaphragm to the attachment of the psoas to the femur. The bulk of the abscess was bounded inferiorly by the crest of the ilium.

Fig. 4. Case 11. Roentgenogram taken five days after Figure 3. Distention of the large and small bowel is again seen and there is now a definite increase in the number, size and extent of small gas shadows on the right side indicative of retroperitoneal abscess.

CONCLUSIONS

Multiple small radiolucent shadows in the retroperitoneal space indicate an abscess or phlegmon.

Recognition of these multiple small gas shadows is possible early in the disease and their true location is facilitated by stereoscopic posterior or oblique projections.

Included are reports of two cases.

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REFERENCES

1. Neuhof, H., and Arnheim, E. E. Acute retroperitoneal abscess and phlegmon; study of 65 cases. *Ann. Surg.*, 1944, *119*, 741–758.
2. Weens, H. S. Gas formation in abdominal abscesses; roentgen study. *Radiology*, 1946, *47*, 107–115.

LYMPHOSARCOMA OF THE HEAD AND NECK*

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LYMPHOSARCOMA is a malignant neoplasm (a cancer) of lymph nodes and lymphoid tissue in general; any organ or tissue of the body may be affected, if not primarily, at least secondarily. The tumor has a characteristic microscopic appearance.

A review of the records at Memorial Hospital indicates that during the seven year period from 1935 through 1941 fifty-four patients with lymphosarcoma were examined and treated on the Head and Neck Service. All cases on first examination at the Hospital presented evidence of lymphosarcoma limited to structures in the head and neck. Routine physical examination, including a roentgenogram of the chest, was otherwise negative for lymphoma elsewhere in the body. Of these 54 cases, 4 are considered indeterminate for statistical study; 3 patients, clinically free of disease, died of other causes in less than five years; one patient, clinically free of disease, was lost track of after fifteen months.

It is the purpose of this paper to analyze the management of and report the five year end-results in the remaining 50 cases.

ETIOLOGY AND GENERAL INCIDENCE

The etiology of lymphosarcoma is unknown and no significant causative agent was noted in this series. According to our records the generalized form of lymphosarcoma is four times as common as lymphosarcoma of the head and neck; 217 cases of generalized disease were treated during the same period as the 54 cases under consideration here.

The disease was found in 29 males and 21 females, the youngest patient being a ten year old boy, the oldest patient a woman, aged eighty-eight. The age distribution of cases, according to decades, is shown in Table I. As would be expected in a form of cancer, the largest number of cases occurred during the fifth and sixth decades.

TABLE I

AGE INCIDENCE
(in decades)

	Cases
10 to 20 years	4
21 to 30 years	4
31 to 40 years	7
41 to 50 years	7
51 to 60 years	14
61 to 70 years	11
71 to 80 years	1
81 to 90 years	2
Total	50

The distribution of cases, according to the anatomical location of the primary growth, is shown in Table II. It is interesting to note that 40 per cent of the entire series presented the primary focus in the tonsil (essentially a lymphoid structure).

TABLE II

ANATOMICAL DISTRIBUTION OF THE PRIMARY TUMOR

	Cases
Tonsil	20
Soft parts of head and neck including nodes	11
Nasal cavity	5
Nasopharynx	4
Antrum (paranasal sinuses)	3
Palate	2
Orbit	2
Tongue	1
Gingiva	1
Pharynx	1
Total	50

The next largest group was found in those cases with the disease first appearing in the soft parts (including lymph nodes) of the head and neck region.

* From the Head and Neck Service of Dr. Hayes Martin, Memorial Hospital, New York, N.Y. Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

PATHOLOGY

Our Pathology Department examined the diagnostic tissue in every case. Twenty-eight cases were classified as lymphosarcoma, reticulum cell type. Twenty-two cases were classified as lymphosarcoma.

DIAGNOSIS

The *clinical diagnosis* of a tumor was not difficult in most cases. Forty-six patients each presented a visible and palpable primary growth from which histopathologically positive tissue was obtained. Two cases were first diagnosed by excision of a palpable neck node, the primary focus in the nasopharynx being found and proved histopathologically at a later date.

One patient upon whom a tonsillectomy had been recently performed elsewhere showed no tumor clinically, and the diagnosis was established on the submitted operative specimen.

One case with lymphosarcoma of the orbit showed only unilateral exophthalmos, without palpable tumor; again the diagnosis was made on the submitted operative tissue from the orbit.

The *pathological diagnosis* was established in 21 cases by tissue biopsy from the primary tumor; 18 cases submitted positive biopsies taken before admission to our service. Seven cases required excisional biopsy of an accessible lymph node for microscopic study. In 4 cases surgical removal of the primary growth resulted in a positive diagnosis being made on the operative specimen.

TREATMENT

Previous Treatment. Treatment given previous to admission on our service consisted of biopsy only in 16 cases, some type of local surgery (excisional biopsy, incision and drainage, etc.) in 7 cases, local applications or mouth washes in 4 cases, tonsillectomy in 3 cases and tooth extractions in 3 cases. In addition 2 patients received small amounts of radiation as well in the form of roentgen rays or radium. One nasal cavity case was subjected to a resection of the nasal septum and a tonsillectomy before a biopsy from the right nasal cavity revealed the true nature of the disease. Sixteen cases were referred directly to us without treatment of any kind.

Certain principles are adhered to in this clinic when using radiation in the treatment of *carcinoma* of the head and neck. External roentgen therapy is administered with the high voltage machine (200–250 kv. at 35 or 50 cm. target skin distance). Low voltage roentgen therapy (100 kv.) at 20 cm. target skin distance is frequently employed for peroral therapy. Circular, oval, or specially shaped portals just large enough to adequately cover the disease are used and a relatively large total dose given by the fractionated dose method. Roentgen treatment is supplemented with one or more doses of interstitial radiation in the form of gold filtered radon seeds.

The above principles, with slight modification, are also employed in the treatment of *lymphosarcoma.* In general, the total dose of roentgen radiation is not as high and radon seeds are not used as frequently. For example, in the series under consideration, only 7 patients received interstitial radiation as part of the initial treatment.

Initial Treatment (to the primary tumor and any co-existing regional metastases). In our experience roentgen therapy has been the treatment of choice and was used in 49 of the 50 cases. The amount of treatment given depended on the size, location, and amount of disease, the number of portals employed, and the judgment of the clinician. Treatment time varied from three to ten weeks. Every case was individualized and treated in accordance with its own particular requirements. The following examples demonstrate in a general way the method of treatment. Roentgen-ray dosage is expressed in roentgens measured in air.

Case 1. E. M., aged sixty-five. Diagnosis: lymphosarcoma right tonsil with metastases to right upper neck nodes. Treatment: 250 kv., 50 cm. target skin distance, 9 by 6 cm. oval right mandibular and upper neck portal; total

dose 4,200 r; 8 cm. circular left mandibular portal; total dose 4,200 r. Treatment time four weeks. This patient has been free of disease for seven years.

Case II. J. B., aged fifty-one. Diagnosis: lymphosarcoma left cervical lymph nodes. Treatment: 250 kv., 50 cm. target skin distance, 15 by 10 cm. rectangular left neck portal; total dose 4,800 r supplemented with three doses of radon seeds for a total of 23 mc. Treatment time four weeks. This patient died of generalized disease five months later without local recurrence in the neck.

Case III. J. S., aged twenty. Diagnosis: lymphosarcoma of right parotid area with metastases to right upper cervical lymph nodes. Treatment: 250 kv., 50 cm. target skin distance, 9 by 6 cm. oval right mandibular and upper neck portal; total dose 4,250 r. Treatment time three weeks. This patient has been free of disease for five and one-half years.

Case IV. I. R., aged thirty. Diagnosis: lymphosarcoma of the hard palate. Treatment: 200 kv., 50 cm. target skin distance, 4 cm. bilateral circular right and left maxillary portals; total dose 1,500 r × 2; also 200 kv., 20 cm. target skin distance, 5 cm. circular peroral field; total dose 3,000 r. Treatment time three weeks. Patient has been free of disease for nine years.

Six cases received less intensive treatment. Three of these patients discontinued treatment before its completion and all are dead of generalized disease, 1 in four months, 1 in seven months, and 1 in twenty months respectively. The remaining 3 patients received mild treatment because it seemed clinically sufficient in these cases. Although all 3 patients have survived five years or more, we do not feel that this less intensive therapy is to be recommended as a routine.

Surgery was used as the initial treatment in only 4 cases. In these cases surgery was elected to establish the diagnosis and remove a bulky mass of disease. Two of these 4 patients received postoperative roentgen treatment to the operative area. One patient received no further treatment and died in another hospital two months later, supposedly of "sarcoma"; although this case is considered a failure, there is good circumstantial evidence to indicate that death was cardiac in nature and not due to recurrent lymphosarcoma. The fourth patient subsequently received roentgen treatment and further surgery and at present is clinically free of disease.

Treatment of Recurrent Disease and Subsequent Metastases. Twenty-five cases (50 per cent) required additional treatment, either to recurrent disease locally or to the development of new metastases.

The incidence of local recurrence in previously treated areas was infrequent and occurred in only 9 cases (18 per cent).

In 20 cases (40 per cent) the disease eventually progressed beyond the head and neck region and became generalized.

All 25 patients developing further disease were treated with high voltage roentgen rays. Interstitial radon seeds were used as well in 3 cases. One patient was treated with a radon capsule (1,000 mc-hr.) placed in the nasopharynx for a primary growth which became apparent fifteen months after initial treatment to a right neck mass; this patient died five years later of coronary occlusion and without further evidence of lymphosarcoma.

Surgery was used for recurrent disease in 1 patient only. This remarkable case was treated by partial right neck dissection for recurrent disease in the right upper neck which persisted despite the use of heavy roentgen therapy. The initial treatment given twenty-two months previously consisted of a left radical neck dissection for a bulky mass of disease in the left neck. The patient is now clinically free of disease six and one-half years later.

Complications of Treatment.

Immediate Complications: Most of these patients developed the usual skin reaction and mucositis associated with radiation therapy. These reactions caused no particular problem when given routine hygienic and supportive care. The weight and general condition of each patient was maintained as well as possible during the treatment period with a high caloric, high vita-

min diet. One patient required tracheostomy for acute laryngeal edema. Another patient with bulky disease in both tonsils died of asphyxia before a tracheostomy was done.

Late Complications: Three patients developed marked radiation atrophy with crusting of the nasal and pharyngeal mucosa; undoubtedly, more patients suffered from this complication than the records indicate. One patient required enucleation of the right eye for radiation necrosis of the cornea.

PROGNOSIS

It is a generally accepted principle when dealing with lymphosarcoma to record "five year survivals" rather than "five year cures." The chronicity and unpredictable course of the disease make this classification necessary.

In this series, 23 patients (46 per cent) presented only the primary tumor on initial examination; 14 (per 61 cent) have survived five years or more. Only 5 developed cervical lymph node metastases later, and 3 of these have survived five years or longer.

Twenty-seven patients (54 per cent) presented one or more enlarged cervical nodes in addition to the primary mass when first examined; 12 (44 per cent) have survived five years or more.

In 20 cases (40 per cent) the lymphosarcoma became generalized and in this group there is only one five year survival (5 per cent).

It can thus be seen that the prognosis is most profoundly affected by whether the disease becomes *generalized* or not. In a careful analysis of this series of 50 cases it has been impossible to uncover any single factor or factors which will indicate the subsequent course of the disease. Whether an individual case will go on to generalized dissemination of the lymphosarcoma or not seems to depend on an unknown characteristic of the disease. It is highly probable that some patients already have unrecognized generalized disease when first examined and when positive findings are clinically still localized in the head and neck region.

Clinical observation has shown that a patient may present either a single focus of disease or multiple and widespread foci; both unicentric and multicentric forms of lymphosarcoma are constantly encountered. To us as clinicians, it seems reasonable and practical to consider the disease localized and unicentric in origin when initial positive findings are limited to the head and neck. It is this attitide which has prompted us to treat most of these cases *intensively* in an attempt to sterilize the disease while it may still be localized.

END RESULTS

Table III shows that 26 of the 50 patients (52 per cent) have survived five years or longer. Of these 26 patients, 24 are clinically free of disease and apparently cured; 2 are living with further evidence of disease.

TABLE III

FIVE YEAR END RESULTS
(IN TERMS OF SURVIVAL)

Total Number of Patients	54
Indeterminate group	
Dead of other causes without evidence of disease	3
Lost track of without disease	1
Total	4
Determinate group	
Total number minus indeterminate group	50
Failures	
Dead of disease	24
Successful results	
Patients having survived five years or longer	26
Five year end results	
Total successful results divided by total determinate group (26/50)	52%

Craver has recently reported an over-all five year survival rate of 26 per cent in a series of 308 patients with lymphosarcoma

of all anatomical types treated at the Memorial Hospital during the eleven year period from 1930 through 1940; it is noteworthy that of the 81 survivors, 40 are patients in whom the disease was at first found only in the head and neck region.

In a group of 119 patients treated at the Presbyterian Hospital, Stout reports a five year survival of 23 per cent and a ten year survival of 13 per cent. He indicates that five year survivals are higher in oral cavity and salivary gland patients (37 per cent) than in patients with generalized disease (10 per cent).

It is realized that this analysis is limited to 50 cases and that the high five year survival figure of 52 per cent might be lower in a larger series. However, it seems an indisputable fact that lymphosarcoma of the head and neck carries a relatively favorable prognosis as compared to the generalized form of the disease. The realization of this fact should influence the optimism and aggressiveness with which this anatomical form of the disease is treated.

SUMMARY AND CONCLUSIONS

1. Fifty cases of lymphosarcoma clinically localized in structures of the head and neck are presented for analysis.

2. The etiology of the disease is not known. The distribution between the sexes was about equal. The disease was most prevalent during the fifth and sixth decades.

3. The diagnosis was confirmed in all cases by tissue biopsy.

4. The treatment of choice was high voltage roentgen therapy supplemented with interstitial gold radon seeds in some cases. Surgery was of value in only four cases to establish the diagnosis and remove a bulky deposit of disease.

5. The prognosis in lymphosarcoma of the head and neck is more favorable than in the generalized form of the disease.

6. The five year survival rate in this series is 52 per cent.

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REFERENCES

1. Craver, L. F. *Bull. New York Acad. Med.*, 1947, *23*, 79.
2. Stout, A. P. *New York State J. Med.*, 1947, *47*, 158.

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PANTOPAQUE MYELOGRAPHY IN THE DIAGNOSIS OF THE ARNOLD-CHIARI MALFORMATION WITHOUT CONCOMITANT SKELETAL OR CENTRAL NERVOUS SYSTEM DEFECTS*

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THE Arnold-Chiari malformation of the hindbrain is a downward elongation of the cerebellum and brain stem through the foramen magnum into the cervical spinal canal. A congenital defect which may occur in varying degrees, it is often associated with spina bifida, myelomeningocele and hydrocephalus, but it may also occur in patients with neither skeletal nor central nervous system defects. It has also been reported in conjunction with bony abnormalities of the craniovertebral junction like platybasia and fusion defects of the cervical spine and the occipitocervical area.[6] Its age incidence varies from the newborn infant to patients in adult life, and the diagnosis is usually made on the basis of clinical, and more frequently anatomical observations either at operation or autopsy.

The roentgen findings have not received intensive study, and pantopaque myelography offers an additional diagnostic procedure which is worthy of careful consideration. In April, 1941, List[7] mentioned 2 patients who had had iodized oil myelography as a diagnostic procedure, in one of whom the diagnosis of an Arnold-Chiari malformation was made preoperatively. This patient also had a bony abnormality of the craniovertebral junction. In July, 1941, another and more detailed myelographic study of a patient with an Arnold-Chiari malformation without other abnormalities in the skull or spine was reported by Adams, Schatzki and Scoville.[1] The present communication is concerned with a fourth such patient examined with pantopaque myelography.

CASE REPORT

M. W. (Case No. 282825), female, aged thirty, complained of pain in her left shoulder radiating to the hand, with unusual sensitivity of the skin of her left arm to thermal stimuli. This started three months after the birth of her second child three years before admission to the hospital. Extreme paroxysms of pain could be precipitated by coughing or sneezing. She noted a "burning coldness" almost immediately on placing her hand in cold water, while ordinary exposure to room temperature elicited a lesser feeling of discomfort. Recently a tendency to fall frequently and a perceptible clumsiness in gait appeared. There was no noticeable muscle atrophy.

Physical examination disclosed a left Horner's syndrome. Slight diminution of sensation in the left arm with hypesthesia in the distribution of the fourth and fifth cervical dermatomes was present. The left abdominal skin reflex was less active than the right, and there was some question whether sensation in her left lower extremity was somewhat less than on the right side. The deep reflexes were diminished in the left upper extremity as compared with the right. There were no sphincteric disturbances, nor were there any muscular weaknesses.

Lumbar puncture revealed an initial pressure of 210 mm., which rose to 430 mm. of water with 40 mm. of mercury of jugular pressure applied with a blood pressure apparatus. The pressure fell to 210 mm. in ten seconds. The findings were considered indicative of a partial block. There were 39 cells per cc. of fluid. The total protein content was 35 mg. per 100 cc. The Wassermann and colloidal gold tests were negative.

Roentgenographic examination of the cervical spine revealed a straightening of the usual cervical curve. The vertebral bodies and interspaces were normal, and no changes were pres-

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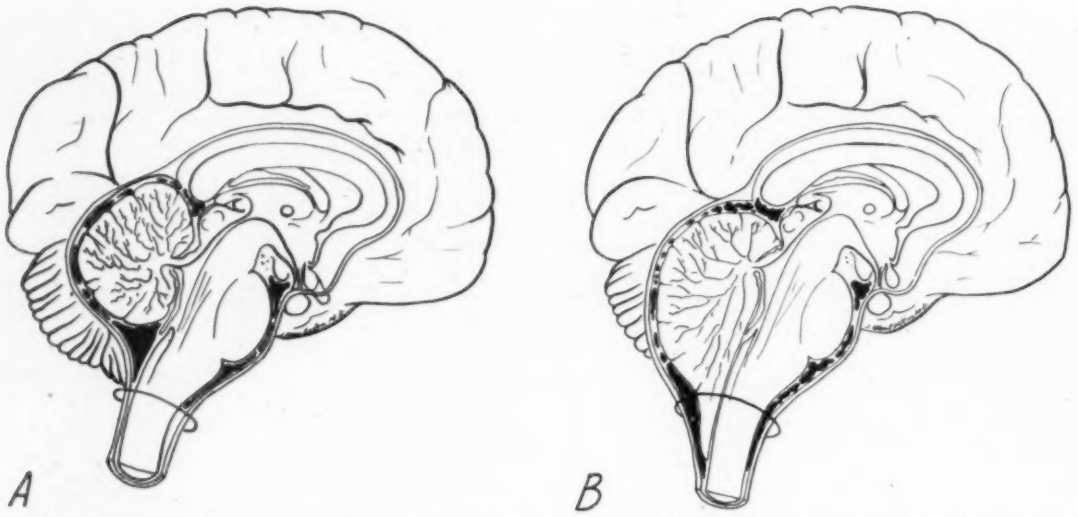

Fig. 1. *A*, diagrammatic drawing of a sagittal section of the normal brain. The opaque medium is represented in black. The downward impression of the cerebellum results in a concave appearance of the cephalad margin of the pool. *B*, diagrammatic representation of the Arnold-Chiari malformation is found in the patient reported here. The pantopaque is collected above and beneath the cerebellar tonsils because the herniated portion of the cerebellar tonsils partially fills and distorts the cisterna magna.

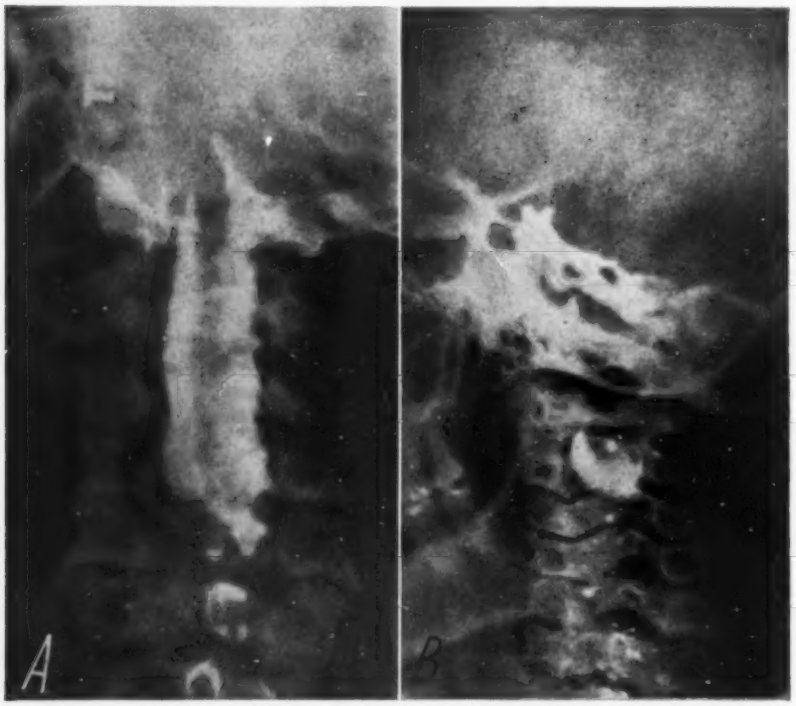

Fig. 2. *A*, normal myelogram of the cervico-occipital junction with the head turned towards the right. The impression of the lower cerebellum into the pool of pantopaque results in a triangular shadow with a slightly concave hypotenuse. *B*, myelogram of the cervico-occipital junction of the patient reported here. The pantopaque is shifted cephalad and caudad by the displaced cerebellar tonsils. The upper radiopaque shadow is caused by the pantopaque gathered above the cerebellar tonsils and the inferior curvilinear defect outlines the lowermost margins of the lesion.

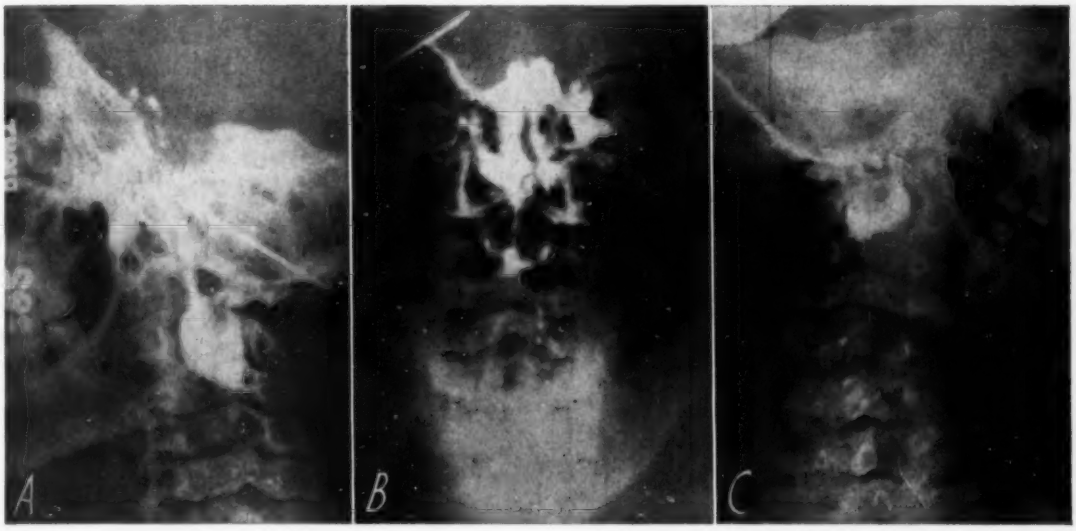

Fig. 3. *A*, the pantopaque is gathered in the upper cervical region. The patient's head is turned toward the right. The curvilinear impression into the cephalad margin of the pool is well portrayed. A small amount of the pantopaque has entered the cisterna pontis. *B*, direct anteroposterior view of the pantopaque gathered in the upper cervical region. A biconcave filling defect with a central isthmus of pantopaque is present. *C*, the same findings as noted in *A* can be seen with the patient's head turned toward the left.

ent in the occipitocervical region. Examination of the lumbosacral and lower thoracic spine likewise showed no skeletal defects.

Myelography was performed after the injection of 3 cc. of pantopaque between the third and fourth lumbar vertebrae. A persistent partial obstruction was encountered at the level of the interspace between the first and second cervical vertebrae. The head of the pantopaque column assumed a semicircular configuration concave caudally. With the patient's head turned toward the left and the right sides the filling defect in the oil column was unchanged. The findings were considered indicative of an intrinsic lesion, probably an extramedullary tumor.

At operation the posterior arches of the first, second and third cervical vertebrae were removed and the occipital foramen was enlarged posteriorly. The dura appeared to be under normal tension and no evidence of tumor was found on palpation. The membrane was opened in the midline for about 2.5 cm. and no gross pathologic changes were found beneath the meninges. After removing the posterior arch of the atlas a mass was seen invading the upper portion of the cervical canal. This was identified as cerebellum, was white in color and covered with a whitish fibrous tissue. The findings were considered indicative of the Arnold-Chiari malformation. No downward displacement of the brain stem could be observed.

Notes on the Roentgenologic Findings

A review of the roentgenograms after operation brought out some interesting details. The direct examination of the cervical spine showed only a change in the normal curvature of the cervical spine. No derangement was present at the occipitocervical junction, and the lumbosacral spine was normal. The myelographic findings were most important. The persistence of the concave defect in the pantopaque column with the patient's head turned to the right and left sides could, on second thought, indicate the presence of a lesion to either side of the midline. A film taken with the patient's head in the direct anteroposterior projection was available. This showed the iodized oil column through the ethmoidal sinuses in the upper cervical canal and the cisternae magna, pontis and interpeduncularis. The bilateral nature of the filling defect was better visualized here. The two radiolucent indentations were separated by a column of oil about 8 mm. wide and 2.5 cm. long. This oil apparently rested in the cleft between the herniated cerebellar tonsils. The outlines of the concave filling defects were rather indistinct, although no gross changes which

might be interpreted as cerebellar gyri could be distinguished.

The configuration of the pantopaque in the cisterna magna as seen with the patient's head turned to the side was most interesting. A slight cephalad convexity of the pool of oil gathered in the cisterna magna was present in the patient with the Arnold-Chiari malformation, and the cisterna pontis seemed to be slightly narrowed. Reviewing a number of other cervical myelograms, it was noted that normally the oil pool in the cisterna magna is concave cauded and somewhat anteriorly, following the normal cerebellar contour. The change in curvature in the patient with the Arnold-Chiari malformation may be understood by referring to Figure 1, which was adapted from that in the excellent paper by Adams, Schatzki and Scoville. Under normal conditions the inferior aspect of the cerebellum is slightly bulged downward, dipping into the cisterna magna whereas with the Arnold-Chiari malformation as seen in the patient reported here the cerebellum slips downward and forward, thus distorting its contour by displacing and changing the appearance of the oil gathered in the cisternae magna and pontis.

The myelographic findings reported by List were an arrest in the passage of the iodized oil in the high cervical region with a filling defect characterized by a concave upper margin. Very little lipiodol entered the cisterna magna and a little more appeared in the cisterna pontis as seen on the line drawings published. The diagnosis of an Arnold-Chiari malformation was made preoperatively on one of his two patients.

Adams, Schatzki and Scoville describe the myelographic observations as portraying "a mass within the upper cervical area which produces a fairly marked block to lipiodol injected below the lesion. The block is less complete than one would expect from a tumor of similar size, the passage into the vault being less impaired than that in the reverse direction. The outline of the mass is less distinct than that of tumor, owing to the sloping surfaces of the soft cerebral tonsils. The edge of the mass shows lobulation produced by the gyri of the prolapsed cerebellum. There seems to be a small central incisura within the mass corresponding to the incisura between the two cerebral tonsils. Some degree of platybasia may be present." There is no doubt that the reference to "cerebral tonsils" is a misprint, the correct terminology being "cerebellar tonsils."

To this adequate picture might be added the changes noted in the configuration of the iodized oil collected in the cisternae magna and pontis, but the latter changes will only occur when a sufficient quantity of oil enters the cisterns.

CLINICAL NOTES

In 1894 Arnold[3] reported the case of a newborn infant with lumbosacral spina bifida and myelocele who also had a protrusion of a portion of the cerebellum through the foramen magnum over the dorsal aspect of the upper cervical spinal cord containing the fourth ventricle. Soon thereafter Chiari[5] classified 63 such cases and described three general types of the malformation. The first was characterized by elongation of the cerebellar tonsils and inferior lobes, enveloping the medulla and extending into the upper cervical canal without downward displacement of the fourth ventricle. This type occurred in adults as well as children and could be associated with internal hydrocephalus without myelomeningocele. The second type presented a more advanced deformity with displacement of the fourth ventricle caudad so that the foramina opened into the spinal subarachnoid space below the foramen magnum. This group occurred in infants with internal hydrocephalus and spina bifida. The third, most advanced and least common type presented a downward herniation of the whole hydrocephalic cerebellum into the cervical spinal canal.

The pathogenesis of the Arnold-Chiari malformation has not been decided with absolute certainty. Some believe that it is most likely a deformity resulting from a change in the relationship of the hindbrain to its bony envelope. Abnormal fixation of

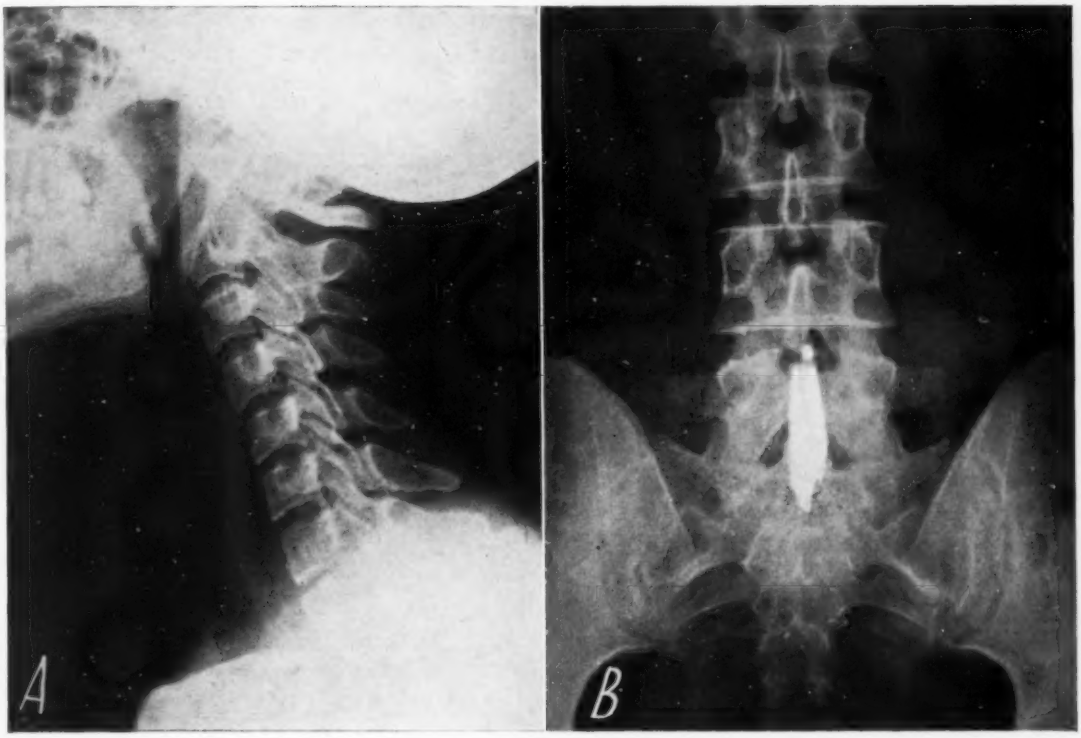

Fig. 4. *A*, lateral roentgenogram of the neck showing straightening of the normal cervical curve. The craniocervical junction is normal. *B*, anteroposterior view of lumbosacral spine. No congenital defects are present.

the spinal cord to its meningeal coverings and roots by a spina bifida defect might prevent normal ascent of the spinal cord with the growth of the spinal column and the development of the cauda equina. The greater the defect and the more caudal its location, the earlier the appearance of the deformity and its concomitant complications.[10] List[7] mentions the fact that the Arnold malformation is a tereotopic displacement of cerebellar tissue into the spinal canal, while Chiari's deformity is a peculiar bulging or kinking of the posterior part of the medulla against the spinal cord. From the clinical viewpoint the two conditions are usually linked and considered as a single entity.

The Arnold-Chiari malformation has also been observed in conjunction with such bony abnormalities of the craniovertebral junction as platybasia and fusion abnormalities of the cervical spine and the occipitocervical area. This group is particularly well reported by List, whose paper deserves careful study.

It is worth reiterating that not all patients with the Arnold-Chiari malformation have associated hydrocephalus, meningocele, spina bifida or anomalies of the craniovertebral junction. Aring[2] reported an adult patient with cerebellar symptoms who had this condition without associated hydrocephalus or meningocele. McConnell and Parker[8] reported 5 similar cases apparently unassociated with other skeletal or central nervous system defects, while Ogryzlo[9] found no other abnormalities in 3 of his cases. Bucy and Lichtenstein[4] reported a case in an adult patient where the malformation was large enough to produce marked neurologic symptoms with no evidence of spina bifida or other bony abnormality, and commented that this combination of circumstances was most unusual. The patient reported in this communication likewise had no other skeletal or central nervous defects, and the entire group was seen to correspond to that mentioned by Chiari in his first type.

The symptomatology presented by the

patients without concomitant skeletal defects may be quite variable. Bucy's patient had partial paralysis of both lower extremities and the right upper extremity which appeared suddenly about three months before hospitalization. There was deviation of the tongue towards the right, ataxia on the right but no signs of increased intracranial pressure. There was atrophy and fibrillar twitchings of the right side of the tongue, hypalgesia of the right side of the body with the exception of the face, nystagmus and bilateral foot drop. The Achilles tendon reflex disappeared later, and marked pitting edema of the feet and ankles then appeared. The abdominal reflexes were absent, and a three plus positive Hoffman's sign was elicited on the right. The tendon reflexes were reduced on the left side. Cerebrospinal fluid examination revealed a complete subarachnoid block and total protein content of 40 mg. per 100 cc.

Ogryzlo described the symptomatology in his patients as varied and inconstant. Cerebellar tumor was the most common preoperative diagnosis, and it was usually not until the surgical exposure was made that the true nature of the lesion was recognized. Early morning headache, cerebellar-type ataxia, nystagmus, palsy of the cranial nerves, visual disturbances, papilledema and vomiting were present in varying degrees. Pain in the suboccipital, occipital or high cervical regions due to compression of the upper nerve roots may occur. Paresthesias in the upper extremities may be prominent. Sometimes pain could be relieved by stretching or forward flexion of the neck, while coughing or sneezing might aggravate the pain.

To this bizarre symptomatology might be added the Horner's syndrome found in the patient reported here.

The findings on examination of the cerebrospinal fluid are helpful. A partial or complete subarachnoid block may be encountered on manometric study. Some elevation of the cerebrospinal fluid protein content may be present[1] but normal values have been reported as well.

SUMMARY

An adult female patient with an Arnold-Chiari malformation without skeletal or other central nervous system defects studied with pantopaque myelography is reported. The myelographic findings present a definite pattern whereby the diagnosis may be established preoperatively. It is suggested that this procedure might possibly find application in the investigation of children with hydrocephalus.

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REFERENCES

1. Adams, R. D., Schatzki, R., and Scoville, W. B. Arnold-Chiari malformation; diagnosis, demonstration by intraspinal lipiodol and successful surgical treatment. *New England J. Med.*, 1941, *225*, 125–131.
2. Aring, C. D. Cerebellar syndrome in adult with malformation of cerebellum and brain stem (Arnold-Chiari deformity), with note on occurrence of "torpedoes" in cerebellum. *J. Neurol. & Psychiat.*, 1938, *1*, 100–109.
3. Arnold, J. Myelocyste, Transposition von Gewebskeimen und Sympodie. *Beitr. z. path. Anat. u. z. allg. Path.*, 1894, *16*, 1. Quoted by Ogryzlo.[9]
4. Bucy, P. C., and Lichtenstein, B. W. Arnold-Chiari deformity in an adult without obvious cause. *J. Neurosurg.*, 1945, *2*, 245–250.
5. Chiari, H. Ueber Veränderungen des Kleinhirns, des Pons und der Medulla Oblongata in folge von congenitaler Hydrocephalie des Grosshirns. *Denkschr. d. k. Akad. d. Wissensch. Math-naturw. Klasse*, 1895, *63*, 71. Quoted by Ogryzlo.[9]
6. Ingraham, F. D., and Scott, H. W., Jr. Spina bifida and cranium bifidum. V. The Arnold-Chiari malformation; study of 20 cases. *New England J. Med.*, 1943, *229*, 108–114.
7. List, C. F. Neurologic syndromes accompanying developmental anomalies of the occipital bone, atlas and axis. *Arch. Neurol. & Psychiat.*, 1941, *45*, 577–616.
8. McConnell, A. A., and Parker, H. L. Deformity of hind-brain associated with internal hydrocephalus. Its relation to Arnold-Chiari malformation. *Brain*, 1938, *61*, 415–429.
9. Ogryzlo, M. A. The Arnold-Chiari malformation. *Arch. Neurol. & Psychiat.*, 1942, *48*, 30–46.
10. Penfield, W., and Coburn, D. F. Arnold-Chiari malformation and its operative treatment. *Arch. Neurol. & Psychiat.*, 1938, *40*, 328–336.

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SPONTANEOUS RUPTURE OF THE KIDNEY

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TRAUMATIC rupture of the kidney is by no means a rare incident and may occur in primarily healthy kidneys as well as in diseased ones, but spontaneous rupture of the kidney occurs rarely and is invariably connected with chronic renal disease. The spontaneous rupture may involve the parenchyma or the renal pelvis or both, depending upon the anatomic localization of the pathologic process. A large variety of renal diseases may terminate in spontaneous rupture and impacted stones make up the majority of the cases reported in the literature, but pyelonephritis, pyonephrosis, tuberculosis and tumor have also been encountered as causative factors.

The exclusion of a minimal trauma to a diseased kidney is not always as easy as it may appear. Often the trauma may be so minimal that the patient has no suspicion or knowledge of any injury and therefore the history fails to reveal trauma. The literature on this subject reveals reports of traumatic rupture of diseased kidneys merely upon muscular effort, therefore strict differentiation between traumatic rupture of a diseased kidney and spontaneous one is not always possible.

In cases of stone impaction, the stone itself may represent the traumatic factor, particularly if ulceration and necrosis of the mucosa of the ureter or renal pelvis takes place. Several cases of rupture in hydronephrosis associated with obstruction of the ureter have been reported which include a case report by Jewett of ruptured hydronephrosis associated with carcinoma of the ureter and other similar cases by Mathe and Oviedo and by Dourmashkin. Spontaneous rupture in hydronephrosis and pyonephrosis without additional ureteral obstruction has been reported by Henline, Abeshouse, Crabtree, and others. The reported case is of interest because an unusually large number of stones escaped through a perforation of the renal pelvis into the perinephric space and along the right psoas muscle downward into the pelvis. As mentioned above, all cases of spontaneous rupture of the kidney represent more or less severe degrees of chronic renal disease. The surgical treatment must necessarily consider this fact and therefore be distinctly separated from the surgical treatment of traumatic rupture of a primarily normal kidney. In the latter condition every attempt should be made to preserve the kidney provided the extent of injury warrants such attempt. In the management of spontaneously ruptured kidneys, however, our aim should be the removal of the diseased kidney (provided the other kidney shows sufficient function to carry on), combined with proper drainage of the perinephric space. This procedure cannot always be carried out as the patient with spontaneous rupture of a diseased kidney is acutely ill with underlying chronic renal disease which will not always warrant extensive surgery. Furthermore, the removal of a chronically diseased, densely adherent kidney may prove time consuming and inadvisable for an acutely ill patient. Incision and drainage should therefore be the procedure of choice in many instances with a secondary nephrectomy at a later date.

The case reported below was hospitalized for only two days and never recovered sufficiently for even an attempt at exploration and drainage of the perirenal space.

CASE REPORT

Mrs. E. J., aged sixty-three, was admitted to the Rhode Island Hospital on August 24, 1942, at which time she complained of aches in the right flank and costovertebral angle, weakness,

FIG. 1

nausea, loss of weight and intermittent hematuria. There was no history of fever or chills at any time. The patient's examination in August, 1942, revealed a blood pressure of 145/60 and there was distinct enlargement of the right kidney with slight tenderness over the right flank and costovertebral angle. The heart was enlarged to the left side. Roentgen examination of the urogenital tract by a preliminary roentgenogram showed enlargement of the left kidney and a large staghorn calculus in the region of the renal pelvis and calices and several small discrete calculi in the lower pole of the kidney. The right kidney was poorly outlined and there was an enormous calcified mass with lobulated borders which probably represented a conglomeration of innumerable small calculi occupying practically the entire kidney (Fig. 1 and 2). Intravenous pyelography showed considerable delay in excretion of dye on the left side with evidence of a moderate degree of hydronephrosis. There was no excretion of dye on the right side.

FIG. 2

The patient left the hospital against advice and before the clinical studies could be completed. No operation was performed at that time. The patient had no medical care until December, 1945, when she was admitted to the hospital for the second time because of nausea, progressive weakness and drowsiness. Subsequently she developed profuse vomiting and became comatose. There was swelling of both legs and moderate dyspnea for two weeks prior to her last hospitalization. The patient's physical examination revealed the following findings: undernourished, markedly anemic patient in very poor general condition. Patient comatose, reflexes markedly diminished. Skin dry and pasty with marked edema of both legs. The breath was uriniferous. Chest revealed scattered moist rales at both bases, the heart was enlarged to the left side and a faint systolic murmur was present over the apex. The abdomen was distinctly tender on the right side anteriorly and over the right costovertebral angle. No definite muscular rigidity over the abdomen. Urinalysis showed traces of albumin, no sugar, occasional leukocytes and phosphates. Urea nitrogen was 63 mg. per 100 cc. and creatinine 3.2 mg. per 100 cc., the blood sugar 316 mg. per 100 cc. The blood showed an erythrocyte count of 1.5 million, leukocyte count of 13,050 with 80 per cent polymorphonuclears, 18 per cent lymphocytes, and 2 per cent monocytes; there was anisocytosis, achromia, polychromasia, and younger forms of neutrophile cells.

Cystoscopy and retrograde pyelography were performed and showed a chronically inflamed bladder with normal ureteral orifices. Preliminary roentgenograms of the urinary tract were

taken before and after catheterization of the right ureter, and retrograde pyelograms were made in anteroposterior and lateral positions. The preliminary roentgenograms of the abdomen showed lack of proper visualization of the renal shadows. On the left side there was a large, irregular, ill defined renal calculus of the staghorn type, and in the region of the renal pelvis there was an ovoid calculus measuring 3 by 2 cm. on the film. There were no calculi in the course of the left ureter.

On the right side the renal structure appeared to be replaced by a conglomerate collection of innumerable round calculi measuring 7 mm. in diameter, and just below the normal confines of the lower renal pole, there was a smaller group of similar shadows which were not massed as close together as those within the kidney. In the pelvis, there were six widely separated calculi of the same size and density as the renal shadows. These could have been within a markedly tortuous, dilated ureter, in the bladder, or possibly within the pelvic cavity, outside the urinary tract. In addition to these calculi, there were several small calcifications, only a few millimeters in diameter, situated in the lower portion of the right renal pelvis.

Retrograde pyelograms (Fig. 3 and 4) showed a moderate ptosis of both kidneys. The position of the calculi in the pelvis had varied but the position of the remaining calculi was essentially the same as on the preliminary films. The tip of the ureteral catheter was opposite the fifth lumbar space, where there was an abrupt angulation of the ureter. The pelvic portion of the ureter had a normal course, but the ureter above the point of angulation was deviated medially and anteriorly, and also dilated. Considerable amounts of dye were injected into the renal pelvis and revealed loss of all anatomical structures. There was no extravasation of dye from the kidney. The calculi in the pelvis were not within the bladder, or ureter, and therefore it appeared evident that rupture of the kidney had occurred, releasing numerous calculi into the retroperitoneal cavity, from the perinephric space, along the psoas muscle and downward into the pelvis.

The patient's condition did not improve and fluids were administered intravenously and oxygen given. The original blood sugar of 316 mg. did not definitely establish a diagnosis of diabetes as the patient had received glucose intravenously the night preceding the blood test. The patient's condition was too poor to consider operation within the next twenty-four hours. She died on December 8, 1945, and permission was obtained to perform an autopsy on the abdomen.

Fig. 3

Fig. 4

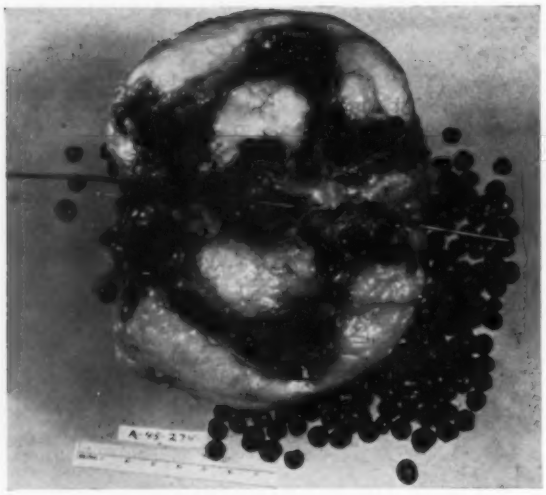

Fig. 5

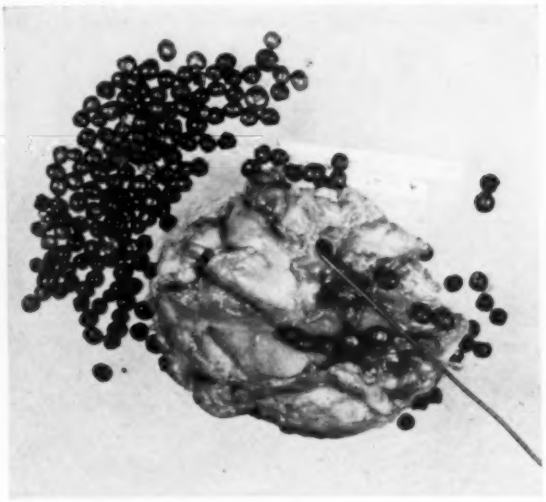

Fig. 6

The postmortem findings were: No fluid in the peritoneal cavity and no adhesions. The splenic capsule is covered by fibrinous exudate. The parenchyma is soft and dark brown, suggesting septic infection. On section there is increased fibrosis. The head of the pancreas is involved in a large mass surrounding the renal parenchyma. The cecum is densely adherent to the perinephric capsule anteriorly and is located in the mid-flank. The ascending colon is closely attached to the hilus of the kidney, but can be dissected from the pelvis without establishing a fistulous opening between the renal pelvis and the intestine. Exploration of the intestine reveals no intrinsic pathology. The liver shows normal appearing parenchyma on section.

The right kidney weighs 275 grams. The parenchyma has disappeared completely. The renal pelvis is markedly dilated and contains about 200 bronze pellets measuring 0.5 cm. each. The renal pelvis has apparently ruptured posteriorly into the perinephric capsule and psoas muscle. An abscess extends into the pelvis as far down as 2 cm. above the obturator foramen. This abscess contains yellow fetid pus and a number of stones similar to the others. The ureter is patent throughout (Fig. 5 and 6).

The left kidney weighs 350 grams. On section there is found a large capsule, and the remaining renal parenchyma measures about 1 cm. in cross section. It is composed mostly of cortex, the medulla has disappeared. The calices are markedly dilated. The ureter contains purulent material. The bladder is small, the wall markedly thickened, the mucosa succulent, yellowish red. There are several ulcerations in the bladder.

The aorta is markedly sclerotic and tortuous and there are ulcerations throughout its extent in the abdomen.

Pathological diagnosis: Bilateral nephrolithiasis and chronic pyelonephritis; rupture of the right renal pelvis, right perinephric abscess.

SUMMARY

The clinical, roentgenological, and postmortem findings are reported in a case of bilateral nephrolithiasis with spontaneous perforation of the right renal pelvis with an unusually large number of stones in the perinephric space and lower pelvis.

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REFERENCES

1. Abeshouse, B. S. Rupture of kidney pelvis. *Surg., Gynec. & Obst.*, 1935, *60*, 710–729.
2. Block, W. Perirenale Urincyste nach Steinperforation des Nierenbeckens. *Ztschr. f. Urol.*, 1932, *26*, 788–796.
3. Crabtree, E. G. Pararenal pseudo-hydronephrosis. *Tr. Am. A. Genito-Urin. Surgeons*, 1935, *28*, 9–40.
4. Dourmashkin, R. L. Stone in ureter complicated by rupture of kidney and subcapsular extravasation of urine. *Urol. & Cutan. Rev.*, 1932, *36*, 670–673.

5. Ferrier, P. A., and Knigge, W. Ruptured kidney. *J. Urol.*, 1943, *49*, 457–459.
6. Floyd, E., and Pittman, J. L. Spontaneous rupture of kidney due to encysted calculus. *J.A.M.A.*, 1931, *97*, 98–99.
7. Henline, R. B. Spontaneous rupture of kidney. *J.A.M.A.*, 1924, *83*, 1411.
8. James, T. G. I. Intraperitoneal rupture of calculous pyonephrosis. *Brit. J. Urol.*, 1933, *5*, 386–387.
9. Jewett, H. J. Spontaneous rupture of hydronephrotic kidney associated with primary carcinoma of ureter. *J. Urol.*, 1940, *43*, 664–668.
10. Larks, G. Spontaneous rupture of hydronephrosis. *Brit. J. Surg.*, 1942, *29*, 354–356.
11. Lazarus, J. A. Spontaneous perforation of renal calyx resulting in urinary fistula, following stricture of ureter. *Urol. & Cutan. Rev.*, 1934, *38*, 316–318.
12. Lowsley, O. S., and Menning, J. H. Treatment of rupture of kidney. *J. Urol.*, 1941, *45*, 253–271.
13. Mathé, C. P. Spontaneous rupture of kidney. *Urol. & Cutan. Rev.*, 1932, *36*, 605–614.
14. Mathe, C. P., and Oviedo, G. F. Spontaneous rupture of hydronephrotic sac secondary to ureteral stone. *California & West. Med.*, 1927, *26*, 790–795.
15. Moore, N. S., and McCarthy, H. H. Perirenal abscess with extension into right pleural cavity following rupture of right renal pelvis. *J. Urol.*, 1944, *52*, 17–22.
16. Nitschke, P. H. Spontaneous rupture of kidney. *Urol. & Cutan. Rev.*, 1938, *42*, 475–479.
17. Rogers, J. W. Diagnosis of spontaneous rupture of kidney pelvis by means of intravenous urography. *J. Urol.*, 1936, *36*, 105–110.
18. Salvin, A. A. Spontaneous rupture of hydronephrotic kidney secondary to calculous obstruction of ureter. *Am. J. Surg.*, 1938, *41*, 288–292.
19. Schmidt, A. Spontanruptur einer infizierten Sackniere. *Ztschr. f. Urol.*, 1931, *25*, 93–97.
20. Speese, J. Perirenal hematoma. *Surg., Gynec. & Obst.*, 1913, *16*, 571.
21. Wade. Spontaneous rupture of kidney with perirenal hemorrhage in acute nephritis. *J. Med. Research*, 1915, *32*, 419.
22. Wallenstein, S. Urinary extravasation at varying levels, with report of 16 cases. *Med. J. & Rec.*, 1928, *127*, 525; 592.
23. Wood, W. Q. Spontaneous rupture of hydronephrosis. *Brit. J. Surg.*, 1923, *10*, 574.

THE USE OF HIGH VOLTAGE ROENTGEN THERAPY IN THE TREATMENT OF AMENORRHEA AND STERILITY IN WOMEN*†

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FOR the purpose of this study I have divided the cases treated by me into two groups: the unmarried patients who sought relief from amenorrhea; the second group, married women who sought relief from amenorrhea and sterility or for sterility alone.

Amenorrhea may be due to numerous and varied conditions. In some cases it is due to congenital or pathological malformations. For these, irradiation is of no avail. Irradiation is useful in those cases where amenorrhea is a result of physiological dysfunction.

The amenorrheic or sterility patient does not come to the radiation therapist directly. She is always referred by her physician or gynecologist, and only when every other method of treatment had been tried and proved unsuccessful. In some cases even artificial insemination was tried but failed.

In nearly every case some sort of endocrine, or drug therapy had been tried and proved unsuccessful. In many instances hormone injections produced vaginal bleeding, probably from a stimulated uterine mucosal hyperemia rather than true menstruation, and when the injections were discontinued no further bleeding occurred. Irradiation, on the other hand, when properly used produced normal menstruation and permitted normal pregnancy in the previously unfertile woman.

Just how irradiation works to correct amenorrhea and sterility is still not definitely known. In the early days of radiation therapy only the suppressive effects of roentgen rays were recognized and only later were the biological and physiological sequences following irradiation an indication of a stimulation effect.

In 1905 Halberstaedter[5] first called attention to the selective action of the roentgen ray on the ovary. It may then be asked, is the relief of amenorrhea following roentgen treatment a direct stimulation effect based on Halberstaedter's selective action findings? Taylor[13] is of the opinion that roentgen rays have such a stimulating effect. Rubin,[11] also believes that the relief of amenorrhea and sterility following roentgen treatment is probably a general reaction to a stimulative effect. The following cases responded to roentgen therapy to the ovaries alone and seem to bear out this assumption.

Case I. Mrs. G. F., aged twenty-nine, was referred for treatment of sterility on April 8, 1927. Menstruation occurred at thirteen and was always irregular and did not improve following marriage at twenty-six. Her last menstrual period occurred in February, 1927. Following a course of medical treatment she was given roentgen therapy administered only to the ovaries on April 8, 15 and 22, 1927. Following irradiation she menstruated regularly for two months, became pregnant and was delivered of a normal baby boy on March 15, 1928.

Case II. Mrs. M. B., aged twenty-four, was referred for treatment of sterility on October 10, 1927. Menstruation began at sixteen, was always irregular occurring at three to four month intervals. The last menstrual period occurred on July 4, 1927. She was married at

* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17–20, 1946.
† The statistics herein presented have been augmented since this paper was presented in September, 1946.

twenty-one, three years before treatment. She had received numerous courses of endocrine therapy and a therapeutic application of the insufflation test without results. Treatment was administered on October 10, 17 and 24, 1927, only to the anterior (100 r) and posterior (150 r) ovarian areas. Following treatment she menstruated regularly until December, 1927, became pregnant and in August, 1928, was delivered of a normal baby girl.

Do the roentgen rays stimulate an undeveloped uterus? The following case suggests such an action.

Case III. Mrs. F. S., aged twenty-four, was referred to me on November 3, 1926, for sterility. Menstruation began at thirteen, was regular at first then gradually became irregular occurring but three or four times per year. Her last menstrual period was in August, 1926. She married at twenty-two with no improvement of the condition. She was of moderate size. The referring gynecologist reported she had an undeveloped uterus. Medication failing to relieve the sterility, she was referred for roentgen therapy. Treatment was given only to the anterior (150 r) and posterior (100 r) ovarian areas, on November 3, 10 and 17, 1926. She responded well, menstruated in December, 1926, became pregnant in January, 1927, and was delivered of a normal baby boy on August 2, 1927.

Do the roentgen rays act in a mechanical manner? We know that one effect of the rays is the production of hyperemia with subsequent swelling of the tissues and in this way perhaps they mechanically cause rupture of an existing ovarian cyst. Stein and Leventhal[12] believe this is the reaction following roentgen therapy. Such cystic ovaries tend to inhibit proper menstruation; when they are ruptured menstruation should follow.

The following 2 cases tend to bear out this assumption of roentgen-ray action.

Case IV. Mrs. M. G., aged thirty-four, referred on January 24, 1929, for sterility. She menstruated at eleven, always irregular and scanty. In 1920 she was operated upon with the hope of correcting her irregularity. A right cystic ovary and an infantile uterus were found. Menstruation was not improved. However, she was married five years later at the age of thirty. There was no change in her condition and, following failure of all other treatment, she was referred as a last resort to me for irradiation. Treatment was administered over the ovaries and the pituitary on January 24, 31, and February 7, 1929. She responded well and menstruated regularly. On December 1, 1929 she was delivered by cesarean section of a normal baby girl.

Case V. Mrs. F. C., aged twenty-seven, was referred on March 17, 1941 for sterility. She menstruated at thirteen, always irregular. She married at twenty-four without relief. In 1940 she was operated upon and was told she had a left cystic ovary. Surgery failed to relieve her irregularity or sterility. Roentgen treatment was administered on March 17, 24 and 31, 1941. She responded well to treatment, menstruated regularly, and on August 16, 1942, was delivered of a normal baby girl.

Rock and his co-workers[10] believe that the beneficial effect is produced by roentgen-ray destruction of one or more follicles which have matured but which failed to rupture and progress through a normal corpus luteum stage, thus upsetting the normal menstrual periodicity. That the persistent corpus luteum may prevent menstruation is definitely recognized and Allen[1] noted that surgical removal of a persistent corpus luteum restored menstrual function. Roentgen therapy may perhaps act in a similar manner as noted in the following case.

Case VI. Mrs. B. E., aged twenty-nine, was referred for secondary sterility on April 6, 1927. She already had one child six years of age but was unable to conceive again. Menstruation began at eleven and was always irregular; the last period was in March, 1927, the previous one in October, 1926. She married at twenty-two. She was obese and the uterus was retroverted. Roentgen treatment was administered to the anterior (100 r) and posterior (150 r) ovarian areas on April 6, 13, and 20, 1927. Normal menstruation followed until July, 1927, when she became pregnant and on April 4, 1928, was delivered of a normal baby boy.

Case VII. Mrs. H. S., aged thirty, referred for amenorrhea and sterility on November 9, 1944.

Menstruation began at fifteen, always irregular, three times per year. She was married at twenty-four and two years later gave birth to a baby—1940, and did not menstruate subsequently for four years. Roentgen treatment was administered on November 9, 16 and 23, 1944. Normal menstruation followed, she became pregnant again and on October 4, 1945, gave birth to a normal baby girl.

What part does the pituitary play in amenorrhea and sterility and in what way does roentgen therapy bring about such influence?

That the pituitary plays an important part in the normal menstrual function has been definitely demonstrated both by laboratory and clinical investigators. About 7 per cent of sterility cases are due to pituitary dysfunction. Just how roentgen rays act on the pituitary is as yet not known. Although roentgen irradiation to the pituitary alone has proved efficacious in some cases, it does not account for the favorable results in all our cases for some were treated only through the ovaries.

Béclère[2] was the first to note the favorable effect of roentgen therapy to the pituitary on menstrual function. Werner[14] noted a definite stimulation of menstruation following irradiation of the pituitary. Borak[3] noted that irradiation of the pituitary ameliorated the climacteric symptoms of early menopause. It is still a moot question whether or not the pituitary can be affected by irradiation in such a manner as to induce hormonal effects in order to bring on ovulation.

Crossen and Crossen[4] state that ovarian function is definitely activated by the pituitary. Johnstone[7] states that the cause of amenorrhea is highly complex and must be something that activates the whole triangular mechanism of the pituitary, ovary and uterus. At the present time we are inclined to attach much importance to the pituitary as a factor in controlling menstrual function. The following cases suggest action from roentgen-ray effect on the pituitary for both these cases had hypopituitary features.

Case viii. Mrs. A. G., aged twenty-seven, was referred on October 27, 1929, for sterility. Menstruation began at seventeen and was always irregular, at three month intervals. The last period occurred on July 10, 1929. Periods were always accompanied with severe pain. She was short, obese and weighed 167 pounds. She was married at twenty-four and had not conceived. Other treatments having failed, she was referred for roentgen therapy. Treatment was given to the ovaries (anterior, 100 r; posterior, 150 r) and pituitary (215 r) on October 27, November 3 and 10, 1929. She menstruated following treatment and became pregnant and gave birth to a baby girl in July, 1930.

Case ix. Mrs. L. R., aged twenty-seven, was referred on September 28, 1943, for sterility. She was very obese and had been taking thyroid, gr. ii, per day for a very long period. Menstruation began at thirteen and was always irregular; the last period was in 1936 or 1937, that is an amenorrhea for about seven years. She married at twenty-four but had not been able to conceive. She had had numerous endocrine injections and a curettage which was reported as "anovulatory mucosa." Roentgen therapy was administered on September 28, October 5 and 12, 1943. Following treatment she menstruated regularly for four months, became pregnant and on October 11, 1945, gave birth to a normal baby girl.

In some cases, the action of the roentgen rays may be due to an effect on the endocrine system as a whole, such as was noted by Hutton[6] and his associates in their study of the effect of irradiation in the treatment of hypertension.

In some cases, although menstruation was apparently regular, the woman was unable to conceive until roentgen therapy was administered. Such action of the roentgen rays we believe might be considered as a general endocrine stimulation effect.

Such a response is illustrated by the following cases.

Case x. Mrs. A. H., aged thirty-two, referred for sterility on July 24, 1941. Menstruation began at thirteen and was regular. She married at twenty-seven but in spite of medical treatment did not become pregnant. There was no gyneco-

logic pathology. Tubes were patent. After five years of sterility and failure of other measures she was referred for roentgen therapy. Treatment was given to the ovaries and pituitary on July 24, 31 and August 7, 1941. She responded well and gave birth to a baby girl on March 9, 1945.

Case xi. Mrs. M. S., aged twenty-five, referred for sterility on October 21, 1942. Menstruated at thirteen regularly. Married at the age of twenty-two and continued to menstruate regularly but although anxious to have a child did not become pregnant. There was no gynecologic abnormality and the tubes were patent. Medication failed to relieve the sterility and she was referred for roentgen therapy. Treatment was administered to the ovaries and the pituitary on October 21, 28 and November 4, 1942. She menstruated regularly following treatment until February, 1943, when she became pregnant and was delivered of a normal baby girl on November 29, 1943.

In my opinion, although we are not certain what may be the specific action of the roentgen rays, it is a stimulation effect. And although we do not know exactly how this stimulation effect takes place roentgen therapy as used by me has successfully relieved amenorrhea and sterility.

During the course of the past twenty-one years, 1925–1946, there were 338 cases referred to me in private practice for the treatment of amenorrhea and sterility; 33 were unmarried and 305 were married women. Of these 1 case refused treatment and 3 cases had but one treatment and failed to complete the course.

Treatment in all instances was solely by irradiation with high voltage roentgen rays administered to the ovaries alone or to the ovaries and the pituitary. In a few instances roentgen irradiation was also given to the thyroid.

The factors used were 200 kv., 4–5 ma., with 0.5 mm. Cu plus 1 mm. Al filter, with a target distance in the early cases of 30–40 cm. and for the past ten years at 50 cm. distance. Treatment was directed through pelvic fields of 8 by 10 cm., 9 by 12 cm., or 10 by 15 cm., and through a 6 by 8 cm. field to the pituitary. Treatment was administered as follows: The first day 50 roentgens was given to the anterior right and left ovarian fields and 75 r to the anterior pituitary area; one week later 75 r was given to the anterior pituitary area and 75 r was given to the posterior right and left pelvic ovarian fields; one week later the anterior right and left pelvic ovarian fields were given 50 r and the anterior pituitary field 75 r. All doses were measured in air.

Occasionally in a very stout patient we add an additional or fourth treatment to the posterior pelvic areas. It is very essential that the roentgen therapy be delivered to the patient at a milliamperage of 5 to 10, never higher. The dose, measured in air, delivered to each part must be timed exactly. For even one minute overdosage may mean the difference between success and failure.

The dose into the ovaries must be between 10–14 per cent of the given dose. Perfect positioning of the localizer must be had in every case and this requires placement by the therapist himself. Only attention to these details produces good results.

As a rule, only one series of treatments was given. However, in 2 instances this rule was not adhered to, because of the insistence of the patients, who previously had been relieved by roentgen treatment and again demanded relief when they ceased to function normally a second time. The following cases illustrate the result of repeated treatment.

Case xii. Mrs. D. O., aged twenty-three when she first came to me on September 28, 1938. Menstruation began at eleven but appeared only once or twice per year. She had medical care without result. Married at twenty-one with no change. Further medical treatment was given without result. She was of heavy build with much hair over the limbs and pelvis. Roentgen treatment was administered on September 29, October 6 and 13, 1938. She responded well and became pregnant and was delivered of a normal baby girl August 7, 1939.

She remained well and menstruated normally

for one year following birth of the baby, then became irregular, every three to four months, and the last period was in November, 1944. On January 9, 1945, she requested roentgen treatment in order to have another child. I was loath to again administer roentgen treatment; however, because the patient was most anxious and the Rubin test proved the tubes patent, treatment was administered. One treatment was given on January 9, 1945, and then because no result was achieved treatment was again given in the regular manner on April 13, 20 and 27, 1945. She responded immediately, became pregnant and was delivered of a normal baby girl on December 11, 1945.

Case xiii. Mrs. A. S., aged twenty-eight, first came to see me on October 24, 1940. Menstruated at thirteen, irregular. Married at twenty-five and had one child following marriage after which menstruation ceased. Medication of all sorts was unavailing. Roentgen treatment was administered on October 24, 31 and November 7, 1940. The result was good and she was delivered of a normal baby girl on May 5, 1942, but it was followed by cessation of menstruation. In October, 1943, she again requested treatment and after much persuasion I again administered roentgen therapy. Treatment was given on October 18, 25 and November 1, 1943. The patient responded well and was delivered of a normal baby boy on March 10, 1945.

Again menstruation stopped completely. In September, 1945, she again requested therapy. I was extremely interested in this case to see whether therapy could be effective once again, a third time, and because all medication given by her physician failed to correct the amenorrhea. Accordingly roentgen treatment was administered on September 21, 28 and October 5, 1945. Menstruation followed but unfortunately on December 7, 1945, she was stricken with anterior poliomyelitis and menstruation ceased. On March 26, 1946, she notified me that menstruation had occurred on March 22, 1946, and lasted for three days normal flow.

There is no doubt that the younger the patient the better the result from treatment. In this series, in the unmarried group the youngest was sixteen and the oldest thirty. In the married group the youngest was eighteen and the oldest forty-five. The largest number of married patients seeking relief were between the ages of twenty-seven and thirty. Of the total of 305 married women 111 were in this age group.

In spite of the adverse reports of abnormalities produced experimentally by irradiation in animals, I have only in one instance, which I reported in 1932[8] seen an abnormal child born of an irradiated mother which abnormality, however, was not proved to be due to irradiation.

While this treatment is not as effective in unmarried women it is harmless, and once the menstruation is restored such patients will when subsequently married give birth to normal children. The following case is illustrative of such a happening.

Case xiv. On May 13, 1929, there was referred to me a young woman (M. M.), aged twenty-one, who was suffering from periods of amenorrhea and severe dysmenorrhea when she did menstruate. Medical treatments of all sorts failed to regulate the periods or relieve the distress. Menstruation began at eleven, was always irregular at about three month intervals. Her last period was on February 7, 1929. Roentgen treatment was administered on May 13, 20 and 27, 1929, to the ovaries and the pituitary. Menstruation became regular at monthly intervals and occurred without pain. In 1931 she married (at twenty-three) and continued to menstruate regularly, became pregnant and gave birth to a normal baby boy on August 4, 1932. On February 7, 1934, she gave birth to a second boy. She continued to function normally and in September, 1936, had an ectopic pregnancy. She now menstruates regularly.

The period of sterility for which treatment was requested varied from several months to many years. The following cases represent an extended period of sterility relieved only by roentgen therapy.

Case xv. Mrs. L. S., aged thirty-three, was referred for irregular menstruation and sterility on January 13, 1925. She was married at the age of fifteen but menstruation began at eighteen and was always irregular. She wished to become pregnant but in spite of all treatments, including surgery and special European treatments, was unable to conceive. As a last resort she was referred for roentgen therapy. Treatment was

administered on January 13, 21 and 30, 1925. She responded well, became pregnant and gave birth to a baby boy on March 19, 1926, and subsequently a baby girl on March 7, 1928, and another boy on April 13, 1930. On February 30, 1931, she miscarried but has menstruated normally since then.

Case xvi. Mrs. E. R., aged thirty-three referred for irregular menstruation and sterility on January 24, 1944. Menstruation began at thirteen, was always irregular, three to six times a year. Her last period occurred on January 11, 1944. She married at twenty and for thirteen years remained sterile. Her husband was tested and found normal. After all other treatments failed, even abroad by foreign specialists, she was referred for roentgen therapy. Treatment was administered to the ovaries and pituitary on January 24, 31 and February 7, 1944. She responded well and became pregnant in June, 1945, and gave birth to a normal baby boy on April 3, 1945.

This study comprises a review of 338 cases. Four of these did not complete the prescribed course of therapy; therefore, only 334 cases were fully treated. Of these 33 were unmarried and 301 were married.

Two hundred and seventy-four cases were followed up; 12 unmarried and 48 married cases were not traced. Of the 274 cases followed, favorable results were achieved in 12 unmarried and 198 married women; and in 9 unmarried and 55 married women treatment failed.

In the favorable result group of 198 married women, after regulation of menstruation 90 became pregnant and went to term and delivered 101 normal children (there was one set of twins); 45 boys and 56 girls. There are 4 women still pregnant. Thirty-two additional cases became pregnant following treatment, of which 18 miscarried, several more than once, 2 had ectopic pregnancies, 1 gave birth to a stillborn child, 3 gave birth to normal children but died shortly thereafter, 6 aborted, some intentionally, there was 1 abnormal birth, and 1 case was deliberately therapeutically aborted.

Of the 301 married women treated, 34 had previous miscarriages, 16 had abortions, 7 had stillbirths, 1 had an ectopic pregnancy, 3 had children who died at birth, 34 had one or more live children before irradiation.

Of those who became pregnant after treatment 20 had more than one child after treatment (so far recorded).

The total who had normal full term pregnancies after treatment—90.

Of those who responded successfully and bore children following irradiation, 6 had previously borne children and 1 of these also miscarried, 7 had miscarriages, 2 had stillbirths, 1 had an abortion. One case which responded had miscarried before irradiation and miscarried twice following irradiation.

Based upon my experience of over twenty years of more than 300 women suffering from amenorrhea and sterility, I feel warranted in reiterating my previous conclusions[9] that roentgen irradiation, properly administered, is harmful neither to the mother nor to the offspring and that it has proved a valuable therapeutic procedure for the treatment of amenorrhea and for the relief of sterility.

In conclusion, I wish to add one word of caution. This type of irradiation, to secure effective results, must be administered only by the trained and experienced radiologist whose apparatus is properly and carefully standardized to permit accurate dosage measurement.

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REFERENCES

1. Allen, E. Physiology of estrogenic principles. *J.A.M.A.*, 1935, *104*, 1498–1502.
2. Béclère, A. *Paris méd.*, 1926, *13*, 97.
3. Borak, J. Die Röntgentherapie und die Organotherapie bei innersekretorischen Erkrankungen. III. Wechselbeziehungen der Drüsen mit innerer Sekretion im Klimakterium. *Strahlentherapie*, 1925–1926, *21*, 31–55.
4. Crossen, H. S., and Crossen, R. J. Amenorrhea; menorrhagia; metrorrhagia; delayed menopause. *Am. J. Surg.*, 1936, *33*, 345–368.
5. Halberstaedter, L. *Berl. klin. Wchnschr.*, 1905, *42*, 64–66.

6. Hutton, J. H. Recent advances in endocrine diagnosis and treatment. *J. Lab. & Clin. Med.*, 1936, *21*, 736–742.
7. Johnstone, R. W. New physiology of menstruation and its practical applications in obstetrics and gynecology. *Am. J. Obst. & Gynec.*, 1930, *19*, 167–180.
8. Kaplan, I. I. Report of case of abnormal fetus following radiation of mother. *Am. J. Obst. & Gynec.*, 1932, *23*, 426–427.
9. Kaplan, I. I. 1940 Year Book of Radiology. Year Book Publishers, Inc., Chicago, pp. 261–272.
10. Rock, J., Bartlett, M. K., Gauld, A. G., and Rutherford, R. N. Effect of subcastrative roentgen therapy on ovarian physiology. *Surg., Gynec. & Obst.*, 1940, *70*, 903–913.
11. Rubin, I. C. Sterility associated with habitual amennorhea relieved by x-ray therapy. *Am. J. Obst. & Gynec.*, 1926, *12*, 76–88.
12. Stein, I. F., and Leventhal, M. L. Amenorrhea associated with bilateral polycystic ovaries. *Am. J. Obst. & Gynec.*, 1935, *29*, 181–191.
13. Taylor, H. C., Jr. Relation of chronic mastitis to certain hormones of the ovary and pituitary and to coincident gynecological lesions. Part I. Theoretical considerations and histological studies. *Surg., Gynec. & Obst.*, 1936, *62*, 129–148. Part II. Clinical and hormone studies. *Ibid.*, 562–584.

DISCUSSION

Dr. William Harris, New York, N. Y. Dr. Kaplan should be congratulated on his lucid and timely paper. It is heartening to hear again of man's successful effort to aid in the creation of life rather than the discovery of new machines and weapons to destroy it. Although doubt may have existed previously as regards the efficacy of roentgen therapy for sterility, Dr. Kaplan's series of cases is large enough to make it statistically significant.

There was considerable interest in this treatment during the twenties, but its use has been greatly eclipsed and narrowed during the last fifteen years following the discovery of new and potent endocrine products. Up to the present, no endocrine products other than thyroid extract have been found to have any value in sterility (functional), and this only in a small percentage of patients who showed some of the stigmata of hypothyroidism.

Another factor which played a role in the general apathy toward roentgen therapy for sterility was the possible chromosomal damage inferred from the work of Muller and other geneticists. Thus far there has been no such evidence of damage in human beings. Naturally, a distinction must be made between irradiating a fertilized ovum and fetus and the treatment of a sterile patient. In the former case, there is no question regarding lethal damage that can be produced by irradiation.

The question of harmful effects on the second generation cannot as yet be determined by Dr. Kaplan's study, but this information will no doubt be forthcoming soon. I know of two radiologists who, after a number of years of sterility and azoospermia due to exposure to radiation, had a return of normal spermatogenesis, and each became the parent of two children who later had normal children of their own. Further light will probably be thrown on this important subject in some years when the radiation effects of atomic bombs dropped on Hiroshima and Nagasaki can be evaluated in light of possible chromosomal damage.

The fact that many of the patients had only one child after treatment, would make me hesitate to treat unmarried patients whose only complaint is oligomenorrhea or complete amenorrhea.

As regards the mechanisms underlying the successful use of roentgen rays in these patients, our information is meager and theoretical. Further studies to determine the presence of absence of ovulation by endometrial biopsies, etc., might prove helpful. In some cases, the effect of roentgen rays on the lipoids of a persistent corpus luteum forms an intriguing hypothesis. I believe that the word "stimulating" is a poor choice because irradiation is always destructive in some degree. May I suggest the "alterative" effect of radiation until we have a more precise term.

This treatment deserves greater popularity and should be called again to the attention of gynecologists and obstetricians who are at present so often helpless in the treatment of sterility.

Again may I thank Dr. Kaplan for recalling this important subject to us and to congratulate him on his excellent results.

Dr. Kaplan (closing). I thought that the geneticists might say something. Dr. Henshaw asked me a few questions yesterday which I tried to answer and maybe I answered them properly.

We don't know exactly everything from the genetic standpoint. I am hoping to have a second generation baby pretty soon, from the first

young woman to get married in the group. I was unfortunate to have only boys born in the first batch. Everybody wants boys, but as yet none have reported marriage or progeny.

However, from this girl who is now married I expect to see a baby and then I can tell you about the second generation, but only in the one instance in my series about which I published a report has there been an abnormal child.

As to the treatment, no case comes to me who has not already been to the gynecologist. I do not take the cases direct, everything has been done before they reach me so I can't say anything about the gynecological reasons for their not having a baby.

Dr. Harris brought up the point about repeating the treatment. He is absolutely right. I was loath to repeat it. But these cases had been treated with a minimum of a year in between courses, and I thought perhaps it would work and, as you see in two cases it did work.

I have a third one that has become pregnant. I don't advise repetition of treatment. It is a one-treatment method of relieving sterility.

How does irradiation work? I used the word "stimulation" because I have no other word. It may be better, as Dr. Harris suggests, to say that it has a regulatory effect. I am not quite sure. How many children will they have after this? I did not give that figure but I will check on that in the next report. There are at least 30 per cent of these women who have had several children after irradiation so it isn't just a one-baby effect at all, and it is a worth while procedure.

There is one thing I want to call attention to. This treatment is something that only the trained radiologist can do. It cannot be rented out by the hospital superintendent, as they are doing with radium, nor can it be given in the form of a little x-ray here or there. It must only be given by the trained radiologist and I would like to see more of you use it because it is worth while.

Question: What percentages of your total cases become pregnant?

Dr. Kaplan: Over 50 per cent of the 198 married women traced. There were 126 pregnancies, 90 successful and 32 incomplete, and 4 still pregnant. It is a good percentage of those that were traced.

THE TREATMENT OF KELOIDS BY IRRADIATION AND ELECTROSURGERY*

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KELOIDS have been treated by irradiation during the past forty-seven years. Ullmann, Albers-Schönberg, Morton, Pusey, and Allen were the first to report the usefulness of roentgen rays in the treatment of keloids and hypertrophic scars as early as 1900. Williams was the first to employ radium for this purpose in 1910. Wickham and Degrais, at about the same time, reported the successful treatment of a number of cases.

One of us (G.E.P.) presented a paper before the Section on Dermatology and Syphilology, at the 71st Annual Meeting of the American Medical Association, April, 1920, in which he recommended the use of radium combined with excision in the treatment of keloids.

Keloids may range in size from a slight thickening of scar tissue and from an area a few millimeters in diameter to tumors as large as an adult fist, or even larger. There may be keloidal bands which cause disfigurement by drawing the soft parts out of position, such as occurs about the mouth or eyelids (see Fig. 1). Keloids may be red, brown or the normal color of the skin, and even paler than the skin. There may be a telangiectasis before receiving any irradiation. At times, they are pedunculated. They may be sensitive to pressure. Keloids that have existed for a long time and those that have developed very slowly are likely to be firm and even hard to the sense of touch. Recent keloids and those of comparatively rapid growth are rather less hard to the palpating finger.

The underlying constitutional cause of the formation of keloids we believe is not known, but the exciting cause is known to the members of this Society. It is traumatism, and the traumatism does not always refer to some operative procedure. We have repeatedly seen keloids develop on the basis of a small "pimple" which has been scratched by the patient. This occurs especially in the upper sternal region. There must also be some local factor which is active in the etiology, for we have noticed in the removal of a number of moles from a patient by electrodesiccation that one or more of these show hypertrophy when other lesions on the same patient, and apparently of the same character, show no such hypertrophy. This indicates the cause is not merely a consitutional one.

Since we do not know the actual constitutional or local cause, we will deal in this presentation only with the treatment of the lesion. Usually the patient seeks relief because of deformity or for cosmetic reasons, but occasionally pain is a prominent symptom and brings the patient for treatment. In other cases, the keloid may cause actual mechanical obstruction as when they occur on the feet and interfere with the wearing of shoes.

MacKee says, "Today there is pretty general agreement that irradiation alone in most cases, and combined with surgery in some cases, constitute the best method of combating keloids and hypertrophic scar. It is the only method of treatment that insures against recurrence."

Keloids or hypertrophied scars are difficult to treat. It requires much patience on the part of both the patient and the physician. So far as is known, the roentgen rays and radium are the only two agents which will arrest the disease or cause it to disappear. If these agents are used thoroughly when the scar begins to hypertrophy, there will probably be no need of combining excision or electrosurgery with the radio-

* Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

therapeutic effect. It is because of the frequent neglect of hypertrophied or growing scars that it is necessary to again call attention to these methods of treatment. If the general practitioner, the surgeon and the dermatologist are alert and apply skillfully the roentgen rays and radium to scars that are beginning to show hypertrophy, keloids will cease to be a problem in the field of medicine. It is true that in many instances slight wounds (especially in the colored race) lead to the formation of large keloids and often these cause so little inconvenience to the patient that they are likely to be neglected until they have reached a considerable size.

Because of the great tendency of recurrence in the wound after excision and very generally because the second keloid is larger than the first, the surgeon feels almost helpless. This helplessness is unnecessary if the surgeon will combine the skillful application of irradiation to the wound after his excision of the keloid. If we make it more generally known that radium and the roentgen rays will prevent these growing scars and generally cause their disappearance, patients will be more likely to seek

Fig. 1. (See page 381 for legend.)

assistance. While keloids or hypertrophied scars occur more frequently in the colored race, they are by no means confined to that race and most patients who have come to us for treatment of the condition have been white.

The early work, like most radiation therapy in those days, was done by fractional and indefinite dosage. Even with this indefinite method, some brilliant results have been obtained. Today, with more definite technique, much skill and much keen judgment will still be necessary to obtain the best results for no two cases react in exactly the same way. Generally, the aim should be to produce a progressive atrophy without erythema or destructive effect on the skin or overlying epithelium. The technique will vary considerably with the size or thickness of the keloids, especially in the cases in which the roentgen rays alone are used. The thicker and older keloids will require more irradiation and more filtration and correspondingly a longer course of treatment. In the more recent cases of hypertrophied scars in which the scar tissue is still young, considerably less treatment is necessary, and less filtration, because it is likely to be more superficial.

Fig. 2. (See opposite page for legend.)

Importance of Early Treatment. Nothing could be more important in the discussion of this subject than early and immediate treatment when the physician can observe any tendency to hypertrophy of the scar. It is true that some scars show a little tendency to hypertrophy and later undergo atrophy and need no treatment, but it is better if one does not wait for any such spontaneous recovery. If one can treat keloids within a month or two after the

Fig. 3

Fig. 1, 2 and 3. Case 1. This case is presented in more detail because it has involved more problems and a longer period of treatment than any other patient. At about six years of age, this child was severely burned on the face by the explosion of a coal oil lamp. This burn was followed by an extensive keloid formation involving both sides of the face and chin, and mouth and submental region. She was first referred to one of us (G.E.P.) for roentgen treatment of the keloids on December 4, 1922, at the age of nine years at the Medico-Chirurgical Hospital. *A*, photograph made December 4, 1922. *B*, January 7, 1924, which indicates considerable improvement. *C*, September 20, 1926, which shows more improvement. *D*, February 18, 1929. The treatments in this case were given with fractional doses representing approximately 50 per cent of an erythema dose using monthly intervals, and later at intervals of two months. We used low voltage rays, 125 kv., 5 ma., and 2 mm. Al filtration at 30 cm. distance. After the greater part of the keloid formation had disappeared, we increased this dosage for local smaller areas to an 80 per cent erythema dose at intervals of two or more months, always aiming to keep the irradiation to the minimum. On January 7, 1929, the patient showed no evidence of any keloid formation, but there were loose folds of tissue near the angles of the mouth, which at my request Dr. Robert Ivy removed surgically, and we then controlled the wound during the granulating period by means of localized doses of roentgen rays, using 80 per cent doses of unfiltered radiation.

hypertrophy has been recognized, the keloidal tendency will be arrested usually by irradiation alone, either with the roentgen rays or by the use of radium. Either of these agents will produce a satisfactory result, and either can be used according to

Fig. 4. The contraction of the lower lip was not entirely satisfactory and Dr. Robert Ivy advised on November 15, 1933, that this scar tissue be removed surgically and a local skin graft applied, which was done by him. No further treatment was given after that date.

the convenience of the radiologist. For that reason, we are discussing in erythema dosage rather than in terms of details of the application. It is taken for granted that every radiologist who is competent to apply treatment to such lesions has at least mastered the knowledge of the erythema dose and the factors that produce it, whether radium or roentgen radiation is used.

The most frequent and the most extensive keloids follow burns. Therefore, the attending surgeon or physician should give special attention to the scars following the healing of extensive burns for, as is well known, such burns when associated with keloids lead to contractures, deformities, and distressing appearances.

Even a very small scar undergoing hypertrophy, for example if it is located on the upper lip or somewhere on a young girl's face, is very important. If treated as soon as this hypertrophy is recognized, one

Fig. 5. The final result after all treatment is shown in *E* (Fig. 1, 2, 3), but the subsequent result on December 5, 1934, five years later, is shown in this illustration.

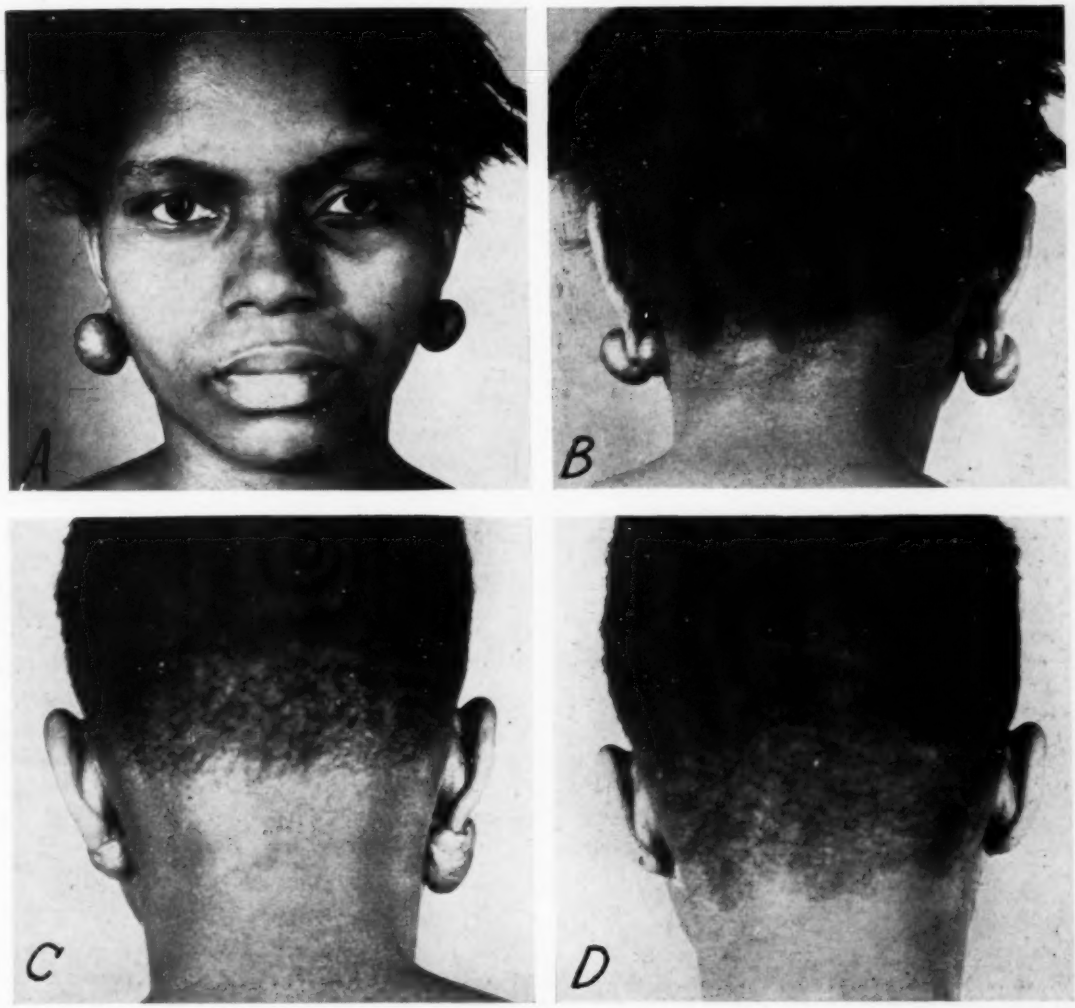

Fig. 6. Case 11. Keloids resulting from punctures of the ear lobe for earrings. *A*, anterior view; *B*, posterior view; *C*, after excision, but no postoperative irradiation showing recurrence; *D*, after excision, followed by irradiation, with no recurrence.

or two treatments with 80 to 100 per cent of an erythema dose given to the hypertrophied scar, and confined only to the lesion, will do no harm and generally will arrest the hypertrophy. This treatment is given with superficial or 125 kv. therapy. If one or two doses do not cause this hypertrophy to disappear then it should be repeated. It is our practice in such cases to repeat these treatments one or two months apart. In these small lesions, one can give a large dose and in our observation it has not done any harm at any time, and the results have been perfect. Even ordinary scars are benefited and made to disappear if treated early by irradiation.

With this thought in mind, when treating even a small lesion on the face we frequently give a postoperative erythema dose preferably about the time that the lesion is healed. We get the impression that this helps to prevent any hyperplasia and even makes the scars less prominent.

In all instances, the larger the area involved the less must be the individual dose and the more frequently it should be applied, especially until the tendency to hypertrophy has been arrested; e. g., in

Fig. 7. Case III. Female, aged forty. Operation Dr. W. L. Rodman. Postoperative treatment February 28, 1916, through the dressings. Wound assumed to be in the upper part of the chest. Microscopical examination showed the lesion to be benign cystic mastitis. Postoperative roentgen therapy was therefore interrupted. Note the keloid formation in the lower half of the wound which received no roentgen treatment.

treating a lesion on the upper lip, 5 mm. in diameter, it is safe to give 80 to 100 per cent of an erythema dose at once, and to repeat in a month or two, but if the lesion is 5 or 10 cm. in diameter, it is unsafe to give such large dosage, and it is better to give a 25 per cent dose at weekly intervals, or a 50 per cent dose at a two week interval.

The Treatment of Older Keloids. The older the keloid the more fibrous tissue has formed, and in all instances where one uses irradiation, it has been observed that the more fibrous tissue there is present in a lesion, the less the response will be of the lesion to irradiation. One must not expect to have large and older keloids disappear from the irradiation without leaving some scarring and atrophy, and perhaps even some telangiectasis. For that reason, it is best to remove the thickened keloid or reduce it to the level of the skin, and then allow it to granulate under control observation, and control postoperative prophylactic treatment.

These older keloids may be removed with the scalpel, by electrosurgical excision, or by electrodesiccation. Because of the general experience that keloids form, especially after burns, it would seem illogical to attempt to remove the lesion by electrosurgery or to destroy or reduce its size by electrodesiccation, but experience has shown that excellent results can be obtained by this means.

In an older keloid, it seems to us that when the keloid is 2 to 5 mm. in thickness, it is best to destroy it or reduce it to the skin level by electrodesiccation. If it is thicker than this, it seems best to remove it either by electrosurgical excision or by excision with the scalpel. Generally it is impossible to close the wound by sutures. Therefore, one must control the tendency to reformation of the keloid after the excision or destruction by means of irradiation. We have had no experience with excision of keloid followed by skin grafting. The tissue excised by Dr. Ivy (Case 1) had been treated by roentgen irradiation and was no longer keloid.

In a previous discussion of this subject one of us recommended preoperative irradiation as a prophylactic measure. We have no proof of the value of such preoperative irradiation. There is abundant proof of the value of irradiation given immediately after operation. An example of this is shown in a breast (Fig. 7) in which postoperative irradiation was given through the dressings following operation for carcinoma of the breast without knowing the full extent of the excision and it is clearly observed that the hypertrophied scar only took place below the area which received irradiation. This is only an illustrative case. An additional proof of the value of postoperative irradiation in preventing recurrence of the keloid is shown by the fact that in all our

experience we have been able to prevent a recurrence of the keloid by means of postoperative irradiation.

The time for the postoperative irradiation is not definitely established but we know from a very extensive general experience that one can give from 50 to 100 per cent of an erythema dose immediately after an operation, or within a few days and this in no way interferes with the healing of the wound. Therefore, it would seem advisable to give 80 per cent of an erythema dose shortly after the operation. At the end of two weeks the scar should be inspected, and the dosage repeated, or after the operative wound has healed if it has been sutured. If the wound is healing by granulation, treatment should be repeated in about two weeks with a 50 per cent erythema dose. After that time, an inspection should occur in at least two to four weeks, and immediate treatment should be given if there is still any tendency to hypertrophy of the scar. Such a method of treatment will do no harm, and will not interfere with the healing of the wound by granulation tissue.

In general, this postoperative treatment is best given by means of the roentgen rays with 1 or 2 mm. Al filtration depending on the thickness of the lesion, and using 125 kv. This will give sufficient depth value and with less superficial destruction of the epithelium. The distance should be regulated according to the size and thickness of the lesion, varying from 30 cm. distance for a small lesion 1 or 2 cm. in diameter, and 1 or 2 mm. thickness; or 50 cm. for a larger lesion, varying from 5 to 10 cm. or more diameter, and 3 mm. or more thick.

When excising a keloid it is inadvisable to make an extensive excision such as one would do with a malignant tumor. The excision can be confined pretty closely to the actual outline of the tumor or keloid.

In some locations, treatment of keloids is more easily carried out with radium than with roentgen rays, or it may be possible to cross-fire with a combination of roentgen rays and radium. Knox used this method to good advantage in the extensive and deep-seated keloidal masses developing in the cheeks. Radium was placed in the mouth and roentgen rays were applied to the external surface of the cheek.

Flat radium applicators are usually employed when treating a keloid with radium. In all cases the "soft" beta rays should be eliminated by suitable screening. If the lesion is more than 1 or 2 mm. thick, only gamma rays should be used. In general, the advice given relative to the roentgen treatment of keloid holds for radium when used for the same purpose. A half-strength, glazed, flat element applicator, screened with 0.1 mm. aluminum, may be placed in contact with the keloid for ten, fifteen or twenty minutes, depending on size, age and location. Treatments may be repeated about once monthly. Such applications are suitable for superficial lesions. Gamma rays are employed for thick, hard lesions. The flat application (half-strength) may be screened with 1 mm. brass, and 1 mm. Al and placed in contact with the lesion for eight to twelve hours. This may be given in one treatment or in divided doses of one or two hours daily. Tubular applicators, containing 25 mg. element, or 25 mc. radon, and screened with 1 mm. brass, 0.5 mm. silver and 1 mm. Al or 0.5 mm. Pt and placed at a distance of 1 cm. or 2.5 cm., may be held over each square inch of surface for from two to six hours.

SUMMARY AND CONCLUSIONS

1. Keloids have been treated by irradiation during a period of forty-seven years. The improvements have been made by combining surgery and electrodesiccation since that time.

2. The tendency to hypertrophy of scars should be recognized usually within a month, at which time they are much more sensitive to irradiation and require much less treatment. At this stage, best results are produced.

3. Telangiectasis may be present even before irradiation, but one should aim to avoid telangiectasis which may be due to irradiation.

4. If the keloids or hypertrophied scars are very dense, it is usually best to destroy the lesions to the level of the skin by electrodesiccation or to remove them by the scalpel or electrosurgery. The healing then must be carefully controlled by irradiation, generally by roentgen therapy.

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REFERENCES

1. ALBERS-SCHÖNBERG, and HAHN, R. Die Therapie des Lupus unter der Hautkrankenheiten mittels Röntgenstrahlen. *München. med. Wchnschr.*, 1900, *47*, 284–325; 363.
2. ALLEN, C. W. Radiotherapy and Phototherapy. Lea & Febiger, Philadelphia, 1904, pp. 244, 288.
3. KNOX, R. Radiography and Radiotherapeutics. Second edition. A. & C. Black, Ltd., London, 1917, p. 562.
4. MORTON, W. J. Artificial fluorescence of living human tissue. *Med. Rec.*, 1903, *64*, 215.
5. MORTON, W. J. Primary and recurrent mammary carcinoma treated by the x-ray. *Med. Rec.*, 1903, *63*, 845.
6. MORTON, W. J. Some cases treated by the x-ray: facial cancer, carbuncle, cheloid, acne, alopecia areata, sychosis, fibroid tumor, psoriasis, and lupus, *Med. Rec.*, 1903, *64*, 121.
7. PFAHLER, G. E. Roentgen rays or radium cobined with excision in treatment of keloids. *Arch. Dermat. & Syph.*, 1920, *2*, 181.
8. PUSEY, W. A., and CALDWELL, E. W. The Practical Application of the Roentgen Rays in Therapeutics and Diagnosis. Second edition. W. B. Saunders Co., Philadelphia, 1904, p. 647.
9. ULLMANN, C. Der Einfluss des Lichtes auf die gesunde und kranke Haut. *Wien. med. Presse*, 1900, *41*, 954.
10. WICKHAM, L., and DEGRAIS, P. Radiumtherapy. Translated by S. E. Dore. Cassell & Co., London, 1910, pp. 160, 172.
11. WILLIAMS. Quoted by Wickham and Degrais.[10]
12. MACKEE, G. M., and CIPOLLARO, A. C. X-rays and Radium in the Treatment of Diseases of the Skin. Fourth edition. Lea & Febiger, Philadelphia, 1946, p. 526.

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PARTIAL DESTRUCTION OF RAT THYROID BY LARGE DOSES OF RADIO-IODINE

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THE scientific literature contains little evidence of the much publicized destruction of the thyroid gland by large doses of radioactive iodine. Relief of hyperthyroidism was obtained by Hertz and Roberts in Boston using from 5 to 25 millicuries of a mixture of $I^{131}+I^{131}$ in human patients. The radiation dose delivered to the thyroid ranged from about 500 to 2,500 equivalent roentgens per gram of thyroid tissue.[1] Chapman and Evans[2] working with doses ranging between 14 and 79 millicuries of the same isotopes obtained clearcut clinical evidence that these amounts reduced basal metabolism and relieved other symptoms of hyperthyroidism. Histological studies were carried out by biopsy in 2 patients, and revealed some fibrosis of the thyroid several months after the radio-iodine treatment. Seidlin, Marinelli and Oshry[3] used radio-iodine to treat a patient with metastasizing adenocarcinoma of the thyroid over a period of three years: the patient received a total of more than 235 millicuries in the form of I^{131} and I^{131}, which supplied an estimated radiation dose of about 40,000 equivalent roentgens to his tumors. The patient was clinically improved and there was roentgenographic evidence of regression of his disease. It has been assumed by these various authors that the thyroid was destroyed by the radio-element, but there is little histological evidence of this fact.

In unpublished work, Leblond and Curtis[4] found that injection of radio-iodine I^{131} into groups of 6 rats in single doses of 0.1, 1, 10 and 30 microcuries respectively caused little or no destruction of the thyroid, as evidenced by data based on weight gain and heart rate and by histological studies. In the group receiving 30 microcuries, there were a few damaged follicles, while numerous mitoses and a general increase in cell size indicated the presence of a compensatory hypertrophy of the thyroid. The doses in this experiment had been calculated on the basis of those used in man by the Boston group. The small extent of the destruction suggested the possibility that the rat thyroid was more resistant than the human. The feeding of the animals, however, on a commercial, iodine-rich diet may have interfered with the entry of iodine in the thyroid.

In order to avoid these difficulties, it was decided to work with a small group of animals fed on a diet of low iodine content and to administer relatively massive doses of radio-iodine. A clearcut, though only partial destruction of the thyroid gland was thus obtained and histologically demonstrated.

METHODS

Five female albino rats weighing between 140 and 180 grams were kept on a low iodine diet for ten weeks prior to the experiment. This diet (Remington No. 342)[5] was composed of: corn meal, 78 per cent; wheat gluten, 18 per cent; dried pig liver, 2 per cent; calcium carbonate, 1 per cent; and sodium chloride, 1 per cent. This diet was shown to produce some hypertrophy of the thyroid and increase the uptake of radio-iodine by this gland in the rat.[6] More recently, in unpublished work,[7] it was found that the thyroids of rats kept on this diet contained 11 per cent of a carrier-free dose of radio-iodine one hour after injection, and 53 per cent, twenty-four hours after injection; thyroids of rats on the same diet which had received drinking water containing iodine in amounts of 2 micrograms per cc. had taken up only 2 per cent of the injected dose, one hour after injection, and 9 per cent, twenty-four hours after injec-

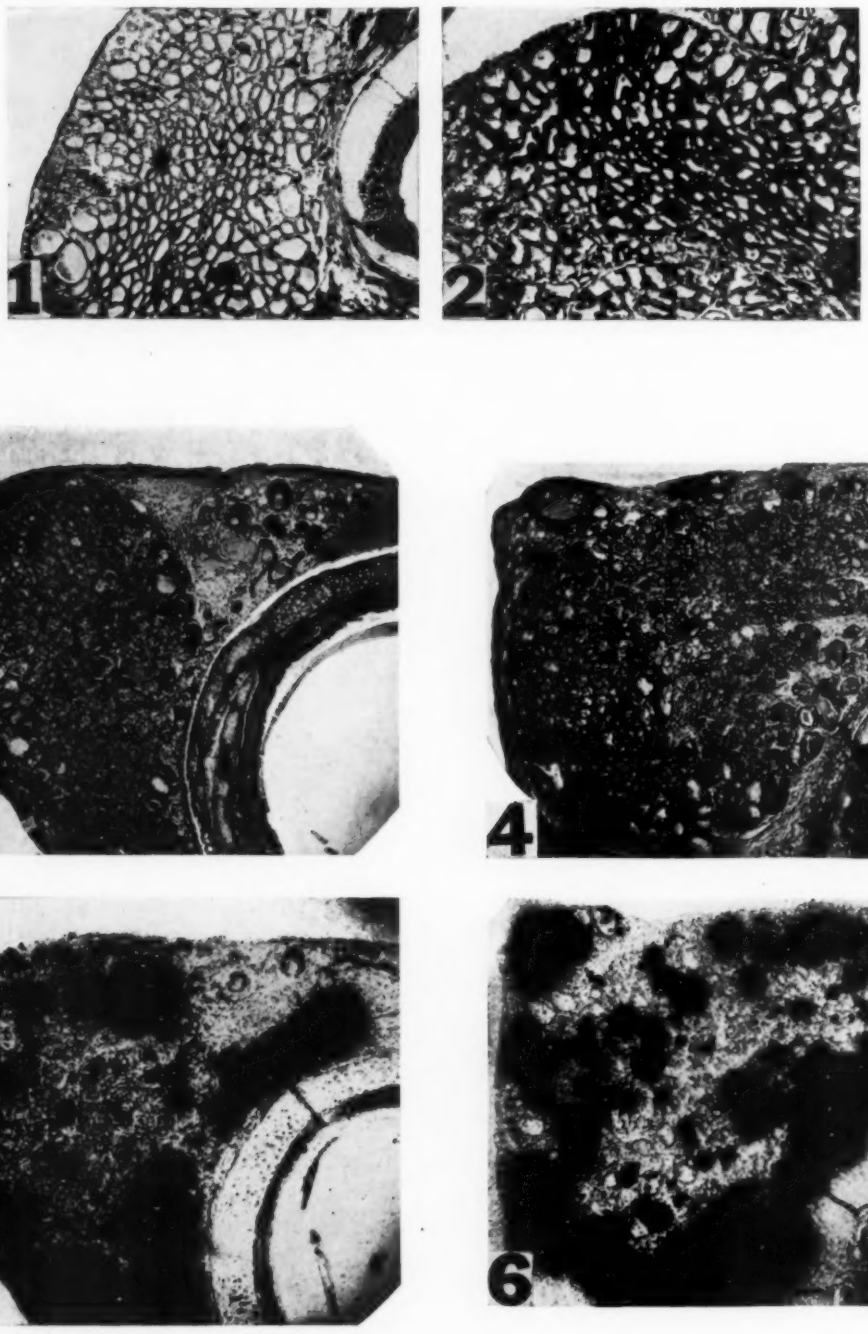


Fig. 1. Thyroid of a control animal showing normal arrangement of fairly evenly sized follicles. Hematoxylin-eosin stain. × 40.

Fig. 2. Thyroid of another control animal showing a more pronounced hyperplasia as indicated by thicker epithelium and smaller colloid accumulations. Hematoxylin-eosin stain. × 40.

Fig. 3. Thyroid of injected animal (A) showing central destruction with a few remaining peripheral acini containing colloid. Hematoxylin-eosin stain. × 40.

Fig. 4. Thyroid of injected animal (B), showing similar results as in Figure 3, except that more normal colloid is visible. A slight fibrous infiltration is apparent. Hematoxylin-eosin stain. × 40.

Fig. 5. Autograph (animal A) showing areas of storage of radio-iodine in peripheral acini. Relatively little

tion. It was expected, therefore, that this diet would favor the retention of a large percentage of the injected dose in the thyroid and thus facilitate the destruction of thyroid tissue. Three animals were used as controls and two animals, A and B, were injected with radio-iodine.

The radio-iodine prepared by deuteron bombardment of tellurium was extracted without addition of carrier iodide. Only the eight day isotope I^{131} was injected. (It was shown that there was no twelve-hour isotope at the time of injection by following the rate of decay of the radioactivity on the Geiger counter.) The animals received a single intraperitoneal injection of I^{131} as sodium iodide. Animal A received approximately 78.5 microcuries and animal B, 60.8 microcuries. The animals were sacrificed exactly six days after the injection of radio-iodine.

The basal metabolic rate of the rats was followed for three days before, and six days after the injection of radio-iodine, by measuring their oxygen consumption for a period of twenty minutes under conditions of rest. At the same time the heart rates were estimated from electrocardiograms taken on each animal.

At autopsy, the left lobes were used for histological and autographic studies. The right lobes of the thyroids were placed in 2 cc. of 2 N sodium hydroxide and heated until digested. Each solution was then dried on a 40 mm. watch glass for three hours at 70° C. The radioactivity was determined by placing the watch glass under the window of a bell-shaped beta-ray Geiger counting tube. The concentration of radio-iodine was estimated by comparison with a standard solution prepared in the same manner.

The histology of the thyroids was examined on sections which included the trachea and adjacent structures, using hematoxylin-eosin and Masson's trichrome strains. The correlation between histological picture and location of the radio-element was studied on radioactive autographs prepared by a method in which the slides bearing the stained sections were dipped into 1 per cent celloidin, dried overnight and coated in the dark room with melted photographic emulsion.[8] The slides were then set aside for exposure in boxes wrapped in black paper. After an exposure period of one to six days, they were developed and fixed according to the usual photographic procedure. On such autographs, black silver granules form in the emulsion coating over the sites of radioactivity in the section (Fig. 14).

RESULTS

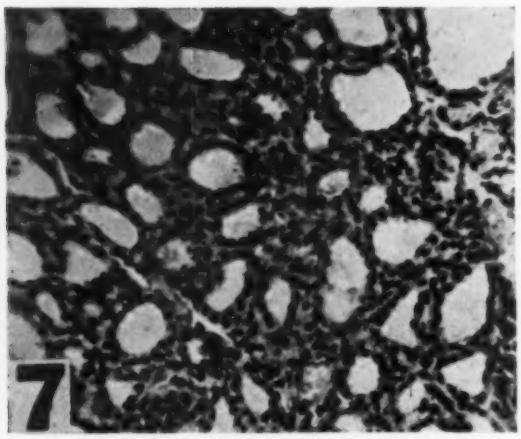
The oxygen consumption of animal A decreased from 63 to 47 cc., and that of animal B, from 55 to 54 cc. of oxygen per hour per square centimeter of body surface. The heart rate of animal A decreased from 468 to 413 beats per minute and that of animal B, from 421 to 339 beats per minute. The values were too few to give an accurate measure of the decrease in thyroid function and should only be considered as indicating a trend in this direction.

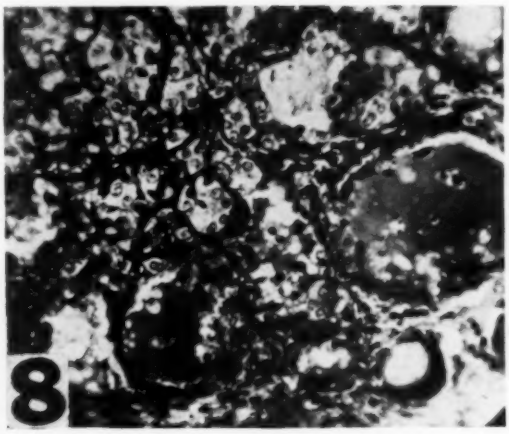
Histological studies of the control groups showed active thyroids (Fig. 1). Under high power, the follicles appeared well filled with colloid (Fig. 7). One of the control glands presented a picture of moderate, diffuse hyperplasia (Fig. 2).

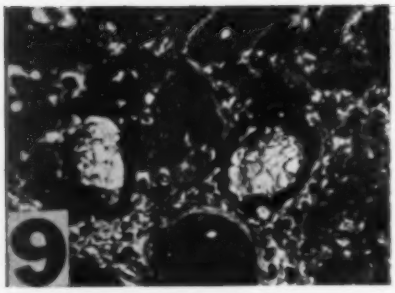
The contrast between the thyroids of the controls (Fig. 1 and 2) and those of the treated animals (Fig. 3, 4 and 14) was striking. Instead of the normal picture of regularly arranged follicles, the treated thyroids showed a transformation of most of the follicles into solid cell groups with

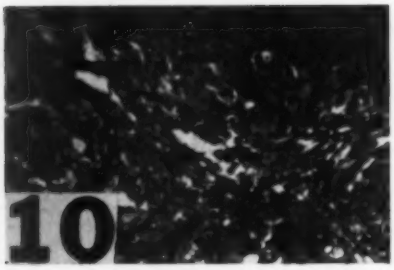
radio-iodine is localized in the central area of the gland. Hematoxylin-eosin stain. × 40. (The autograph was exposed for six days.)

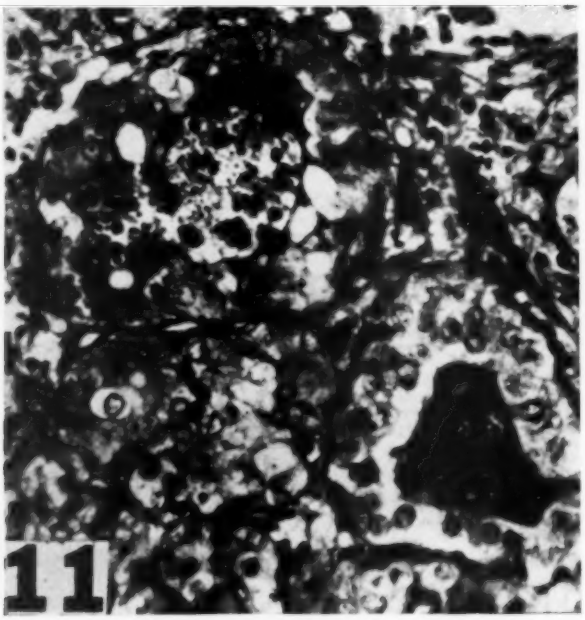
Fig. 6. Autograph (animal B) of a section made nearer the lower pole of the gland than in Figure 4, showing the predominance of radio-iodine deposition in peripheral areas. Masson stain. × 40. (The autograph was exposed for one day.)

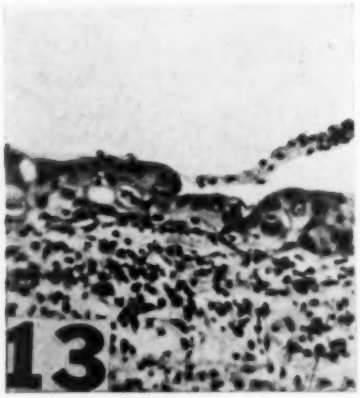












FIGS. 7–13. See opposite page for description.

disappearance of the colloid, especially in the central region of the glands (Fig. 3). In these solid cell groups, the epithelial cells displayed a lack of regular arrangement (Fig. 8, top left). Some of the cells showed cloudy swelling with nuclei which varied in size and were in some cases pyknotic. In others the cytoplasm was transformed into small colloid globules. Some of the cells undergoing this colloid transformation were ejected into the lumen of the follicles (Fig. 11). There was a slight increase in the amount of interstitial fibrous tissue accompanied by scattered lymphocytic infiltration (Fig. 9). Edema was pronounced, especially in animal A (Fig. 3, top center). The peripheral follicles were more normal in appearance, and some of these retained the smooth looking colloid characteristic of normal follicles (Fig. 4). In many follicles, however, the colloid showed a transformation into acidophilic filaments (Fig. 9). These acidophilic filaments were often loosely scattered throughout a follicular lumen retaining some smooth colloid. In some follicles, more numerous acidophilic filaments were found without any recognizable colloid between them. Finally, tightly packed filaments were present in a few follicles, the walls of which had collapsed on the reddish clump of filaments.

The follicles in the thyroid isthmus appeared undamaged and larger than in control animals, the increase in the size of the cells suggesting an intense stimulation.

Tissues surrounding the thyroid showed evidence of radiation injury. The tracheal epithelium adjacent to the gland showed a change from its normal arrangement with columnar pseudo-stratified ciliated epithelium (Fig. 12) to an irregular structure with pyknotic nuclei, disappearance of cilia, cloudy swelling, and subepithelial lymphocytic infiltration (Fig. 13). In areas far removed from the gland, the epithelium was of normal appearance (Fig. 12).* The parathyroid gland showed a few pyknotic nuclei in the areas in closest apposition to thyroid tissue (Fig. 10, arrows). Neighboring cartilage and muscle tissue were not affected.

The amount of radio-iodine present in the glands at the time of autopsy was determined on the Geiger counter. In the case of animal A, 0.67 per cent of the injected dose was present in the right lobe, and therefore it was assumed that the whole gland must have contained twice that amount, namely 1.35 per cent of the injected dose. Similarly, the thyroid of animal B was estimated to contain 15.20 per cent of the injected dose.

The localization of radio-iodine inside the gland was demonstrated by the autographic method. The accumulations of dark granules indicative of the presence of radio-iodine were found chiefly in the peripheral

* The zones of the trachea which were affected by the radio-iodine were located at a distance from thyroid tissue inferior to 1 mm. In man, the distance between thyroid tissue and tracheal epithelium is more than 1 mm., and therefore the danger of damage to the tracheal epithelium with doses of radioactivity similar to those used here is more remote.

Fig. 7. Thyroid of control animal. Hematoxylin-eosin stain. × 168.

Fig. 8. Thyroid of injected animal (A) showing replacement of acinar structure by clumps of epithelial cells (upper left quadrant). Two clearly visible follicles are fairly normal, except for a few damaged cells which dropped into the colloid. Masson stain. × 168.

Fig. 9. Thyroid of injected animal (B) showing fibrillation of the colloid in two follicles. Some increase of fibrous tissue and wandering cells may be seen. Masson stain. × 168.

Fig. 10. Showing parathyroid tissue near the edge of thyroid in an injected animal (A). Arrows indicate pyknotic nuclei. Masson stain. × 168.

Fig. 11. Showing degeneration of acinar epithelium with formation of colloid globules in animal A. Masson stain. × 350.

Fig. 12. Tracheal epithelium in posterior part of trachea, showing normal structure. Hematoxylin-eosin stain. × 168.

Fig. 13. Tracheal epithelium adjacent to thyroid tissue showing pronounced lesions with some lymphocytic infiltration. Hematoxylin-eosin stain. × 168.

areas of the gland (Fig. 5, 6 and 14). Microscopic study showed them to be present only in the colloid of the more normal appearing follicles. Those showing filamentous colloid did not contain radio-iodine. Similarly, little or no radio-iodine was present in the central areas of the gland where the follicles had been replaced by solid cell cords (Fig. 5).

DISCUSSION

That the large doses of radio-iodine damaged the thyroid was suggested by the decline in oxygen consumption and heart rate and was definitely proved by the histologically visible lesions.

The histological appearance combined some evidence of stimulation with intense signs of destruction. The enlarged cells in the follicles in the isthmus may probably be attributed to a stimulation by an excessive release of thyrotrophic hormone resulting from the interference with thyroid secretion. Possibly the colloid degeneration of many cells throughout the glands may also be the result of this stimulation, since such degeneration is a common occurrence in our experience in rats treated with thyrotrophic hormone. The ejection into the follicular lumen of cells undergoing colloid degeneration may also be seen in activated thyroids.

The symptoms of destruction were maximal in the central areas of the gland where the follicles were replaced by solid groups of irregularly arranged and often damaged cells. The more pronounced destruction of the central part of the thyroid was probably a consequence of the more rapid entry and turnover of iodine which takes place in this part of the gland as could be shown with small doses of radio-iodine.[7] In the peripheral areas of the gland, more normal looking follicles than in the center may be seen, but even some of these showed signs of damage. An unusual pattern of destruction could be observed in those follicles. At first, acidophilic filaments appeared in the colloid. These filaments increased in number as the normal smooth looking colloid decreased in amount. Finally, the follicular lumen was packed with the filaments and the walls collapsed, this apparently being the last step before disappearance of the lumen contents and disorganization of the epithelium.

The damaged thyroid glands had also lost to some extent their ability to fix radio-iodine. Indeed, animal A, which histologically showed a greater number of damaged follicles than animal B (Fig. 3 and 5) had a thyroid which contained only 1.35 per cent of the injected dose, while the gland of animal B retained 15.10 per cent of it. This observation indicated that the iodine uptake may be used as an index of the vitality of the gland as suggested by Seidlin *et al.*[3]

The autographic results confirmed the presence of more radio-iodine in the thyroid of animal B than in that of animal A and even supplied some explanation of this difference. Most of the follicles in A had been either completely destroyed or showed a filamentous degeneration of the colloid; such destroyed or degenerated follicles did not retain radio-iodine. On the other hand, the thyroid of animal B contained many more normal-looking follicles than that of animal A; and, as a consequence, many more of the follicles had retained radio-iodine.

The more prolonged retention of radio-iodine in the thyroid of animal B—given a smaller dose than animal A—might result in the long run in a destruction equal to that found in animal A—given the larger dose. The retention of radio-iodine by the follicles until they are seriously damaged, as revealed by the autographs, should eventually result in the destruction of all the gland. This behavior should even cancel to some extent the differences in the effect of various doses, since the longer retention of small doses makes them effective for longer periods of time. Practically, however, the destructive action of small doses of I^{131} is limited by the comparatively short half life of this isotope (eight days).

A rough calculation of the amount of radiation delivered to the thyroids of the

animals over the six day period of the experiment showed that the relatively enormous dose of 20,000 equivalent roentgens per gram of thyroid tissue had been effective in these glands.[1] This large dose explains why considerable lesions were produced in six days, despite the well known resistance of thyroid tissue to radiation[11–15], especially in the rat.[4]

single doses of 78.5 and 60.8 microcuries of carrier-free radio-iodine I^{131} respectively. Thyroid function was estimated by basal metabolic rate and heart rate determination. After six days the animals were sacrificed and the thyroid histology studied by means of stained sections and autographs. It was calculated that about 20,000 equivalent roentgens were received by the thyroid glands of the animals.

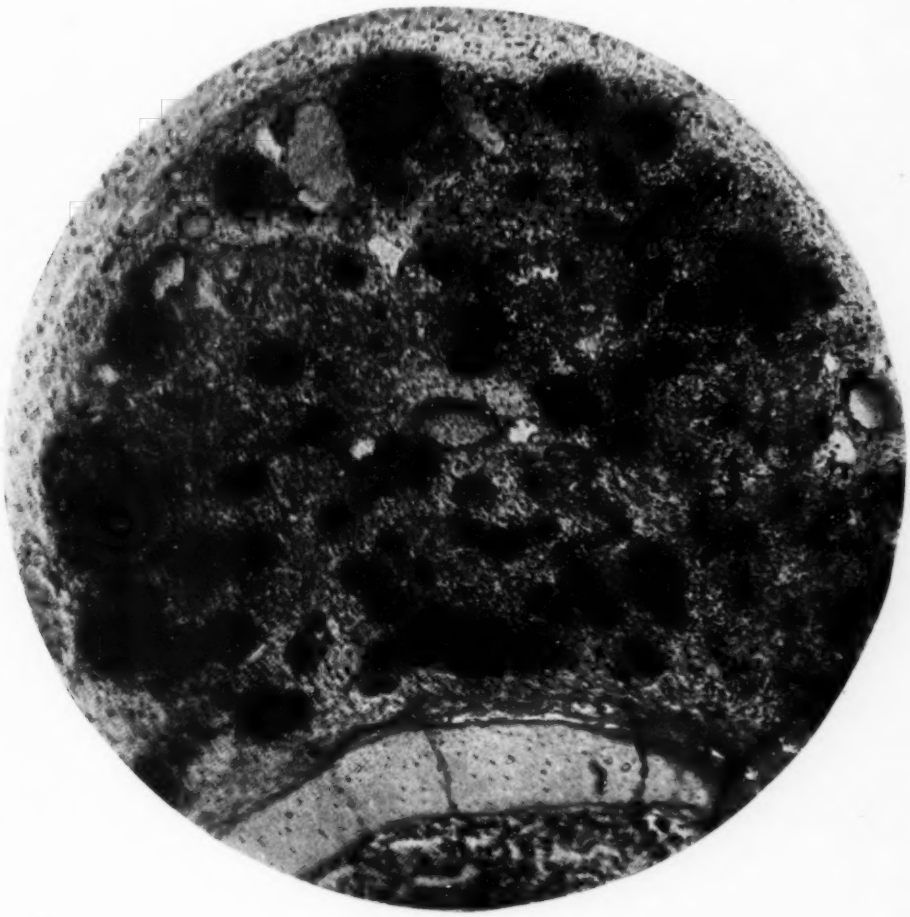


Fig. 14. Autograph of an injected animal (B). The green-staining connective tissue capsule of the gland is visible on the outside. Slight fibrous infiltration (green) and edema are apparent inside the gland. The black masses are the photographic reactions corresponding to the follicles which have retained the ability to take up radio-iodine. The reddish masses correspond to the solid cell cords resulting from the destruction of most follicles by radio-iodine. A few blood vessels are also visible. Masson stain. × 75.

SUMMARY

(1) Two adult female albino rats, kept on a low iodine diet for ten weeks, were given

(2) Such doses of radio-iodine impair the function of the thyroid, as suggested by some decrease in oxygen consumption and

heart rate of the animals.

(3) The histological study of the thyroid glands of these animals shows destructive lesions of the follicles especially in the central areas of the gland (Fig. 3, 9 and 11). Many peripheral follicles retain a normal appearance.

(4) Autographic studies show that only the normal looking follicles with smooth colloid have the ability to retain radio-iodine (Fig. 14).

(5) Although the thyroid gland is resistant to the action of radiations, it can be destroyed by the isotope I^{131} of iodine. The damage is favored by the retention of radio-iodine inside the thyroid follicles until they are markedly damaged.

ACKNOWLEDGMENTS

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The radio-iodine was kindly supplied by Dr. A. L. Hughes and Dr. F. N. D. Kurie as tellurium bombarded in their cyclotron at Washington University, St. Louis, Mo. The extraction was carried out by Dr. S. Albert and Dr. J. Gross in this Department. The measurements of oxygen consumption and heart rate were carried out by Mr. B. Grad. The wheat gluten used in the iodine-free diet was obtained from Ogilvie Flour Mills, Montreal, through the courtesy of Dr. W. Parker.

ADDENDUM

The amount of radiation affecting the thyroid was dependent firstly on the number of injected atoms undergoing disintegration during the six days of the experiment and secondly on the fraction of this injected dose present in the gland—a variable value which for the sake of argument was taken equal to D on the average.

If one neglects the gamma radiation of I^{131} which may be presumed to have negligible efficacy in the small rat thyroid and consider the beta radiation, the problem may be examined in its general form as follows. Let

N_o be the number of isotopic atoms in the injected dose at time o (time of injection),

N_t, the number of these isotopic atoms remaining at time t,

i_t, the number of atoms disintegrating per second at time t,

T, the half-life of the radio-element (equal to eight days in the case of I^{131}); the *average life* of a radio-element is equal to

$$\frac{T}{0.695}$$

days or

$$\frac{T \times 86400}{0.695}$$

seconds,

p, the radioactivity constant, that is to say the fraction of the number of atoms which disintegrates per second (p is a constant, equal to the reciprocal of the average life),

I, the total number of atoms disintegrating during the time interval from o to t.

The basic radioactivity formula supplies the number of isotopic atoms remaining at time t, namely

$$N_t = N_o e^{-pt}.$$

The number of atoms disintegrating per unit time at any time t, that is to say pN_t, will then be

$$i_t = -pN_t = -pN_o e^{-pt}.$$

Therefore the total number of atoms disintegrating and thus effective in the tissues, between time o and t is

$$I = \int_o^t -pN_o e^{-pt} dt = \frac{-pN_o e^{-pt}}{p} + C$$

where C, the constant of integration, may be calculated by making $t = o$. Since in these conditions $I = o$, C is found to equal N_o. Hence

$$I = -N_o e^{-pt} + N_o = N_o(1 - e^{-pt}).$$

The value of N_o may be calculated in the case of animal A which received 78.5 microcuries of I^{131}, that is to say a dose producing $78.5 \times 3.7 \times 10^4$ disintegrations per second at the time of injection. The number of isotopic atoms injected was equal to the total number of disintegrations due to take place during the life of the radio-element, namely:

$$N_o = (78.5 \times 3.7 \times 10^4) \times \left(\frac{T \times 86400}{0.695}\right)$$

$$= (78.5 \times 3.7 \times 10^4) \times \left(\frac{8 \times 86400}{0.695}\right)$$

$$= 2.88 \times 10^{12}$$

This value makes it possible to calculate the total number of atoms disintegrating during the six days after injection:

$$I = 2.88 \times 10^{12}\left(1 - e^{-\frac{0.695 \times 6 \times 86400}{T \times 86400}}\right)$$

$$= 1.19 \times 10^{12}$$

The proportion of this number of atoms disintegrating in the thyroid was

$$\frac{D}{100} \times (1.19 \times 10^{12}) = D \times 1.19 \times 10^{10}$$

Since the average energy of the beta particles of I^{131} is (2.5×10^5) electron volts (Marinelli *et al.*[9]), the energy produced in the gland was:

$(D\times1.19\times10^{10})\times(2.5\times10^5)=D\times2.44\times10^{15}$ electron volts.

On the other hand, 1 roentgen in 1 gram produces (5.22×10^{13}) electron volts (Marinelli[10]), and, therefore, the thyroid of animal A—weighing 0.02 gm.—received:

$$\frac{(D\times2.44\times10^{15})}{(5.22\times10^{13})\times0.02}=D\times2{,}340$$ equivalent roentgens per gram.

Similar calculations for animal B showed that this animal received $D\times1{,}800$ equivalent roentgens per gram of thyroid tissue.

Unfortunately, it was most difficult to obtain an accurate value for *D*. Indeed, *D* could not be computed from data obtained with non-destructive doses of radio-iodine in this and other laboratories, since the ability of the thyroid to take up iodine was impaired by the large dose of radio-iodine as shown by the small amount present in the thyroid of animal A. Another complicating factor was the loss of radiation due to the extension of the I^{131} beta rays range beyond the thyroid, as shown by lesions in parathyroid and trachea. As a rough approximation attempting to take these various factors in consideration, *D* was made equal to 10. The calculated dose of radiation thus became for animal A 23,400, and, for animal B 18,000 equivalent roentgens per gram of thyroid tissue.

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REFERENCES

1. Hertz, S., and Roberts, A. Radioactive iodine in thyroid physiology. *J.A.M.A.* 1946, *131*, 81–85.
2. Chapman, E. M., and Evans, R. D. Radioactive iodine in hyperthyroidism. *J.A.M.A.*, 1946, *131*, 86–91.
3. Seidlin, S. M., Marinelli, L. D., and Oshry, S. E. Radioactive iodine therapy effect on functioning metastases of adenocarcinoma of the thyroid. *J.A.M.A.*, 1946, *132*, 838–847.
4. Leblond, C. P., and Curtis, G. M. Unpublished data, 1944.
5. Remington, R. E. Improved growth in rats on iodine deficient diets. *J. Nutrition*, 1937, *13*, 223–233.
6. Leblond, C. P., and Mann, W. Fixation of iodine by thyroids of rats given diets deficient in iodine. *Proc. Soc. Exper. Biol. & Med.*, 1942, *49*, 102–105.
7. Leblond, C. P., Findlay, D., and Gross J., Unpublished results, 1947.
8. Leblond, C. P., Percival, W. L., and Gross, J. A method for the autographic localization of radio-iodine in stained sections of thyroid gland coated with a photographic emulsion. *Proc. Soc. Exper. Biol. & Med.*, 1948, *67*, 74–76.
9. Marinelli, L. D., Brinckerhoff, R. F., and Hine, G. J. Average energy of beta-rays emitted by radioactive isotopes. *Rev. Modern Physics*, 1947, *19*, 25–28.
10. Marinelli, L. D. Dosage determinations with radioactive isotopes. Am. J. Roentgenol. & Rad. Therapy, 1942, *47*, 210–216.
11. Warren, S. Effects of radiation on normal tissues. *Arch. Path.*, 1943, *35*, 304.
12. Bower, J. O., and Clark, J. H. The resistance of the thyroid gland to the action of radium rays; results of experimental implantation of radium needles in the thyroid of dogs. Am. J. Roentgenol. & Rad. Therapy, 1923, *10*, 632–643.
13. Walters, O. M., Anson, B. J., and Ivy, A. C. The effect of x-rays on the thyroid and parathyroid glands. *Radiology*, 1931, *16*, 52–58.
14. Eckert, C. T., Probstein, J. G., and Galinson. S. Radiation of the thyroid; experimental study in radiosensitivity of the thyroid, *Radiology*, 1937, *29*, 40–44.
15. Garland, L. H., Cutting, W. C., Robson, G. B., and Newman, W. W. Effects of roentgen irradiation on experimental hyperthyroidism. Am. J. Roentgenol. & Rad. Therapy, 1941, *45*, 692–695.

RADIOAUTOGRAPHY

SOME PHYSICAL AND RADIOBIOLOGICAL ASPECTS OF THE TECHNIQUE AS APPLIED TO THIN SPECIMENS*†

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1. THE EXPOSURE TIME

THE determination of the adequate time of exposure in radioautographic techniques is fraught with many uncertainties. As a rule, adequate images are sought by exposing the photographic material to serial tissue sections for progressively longer periods of time. With this procedure the correct time is estimated empirically by observing the results obtained with several suboptimal exposures. This method is tedious and time consuming and yet, by disregarding it, one may be faced with total failure.

While empiricism cannot be excluded in toto, it is possible to reduce both work and uncertainty to a minimum by the application of the elementary laws of radioactivity. Since the reciprocity law (Bunsen-Roscoe) holds for ordinary beta and gamma rays[5] one may expect a certain degree of blackening, D, upon exposure of a certain plate to a given quantity of radiation, L, impinging on a unit surface, irrespective of the time necessary to deliver it. The quantity of radiation, L, is the result of radioactive decay of an element from an amount A_0 per unit surface at the beginning of the exposure t to an amount A_t at the end of it. We may write

$$L = A_0 - A_t.$$

Since

$$A_t = A_0 e^{-\lambda t}$$

($\lambda = \frac{0.693}{T}$, is the decay constant and T the half-life of the element) it follows that:

$$L = A_0(1 - e^{-\lambda t}).$$

Solving for t

$$t = \frac{T}{0.693} \log \frac{A_0}{A_0 - L}. \qquad (1)$$

This equation gives the required exposure time t in terms of the half-life of the element, the initial activity A_0 per unit surface of the tissue section and the activity L, which the section must lose, in order that a given blackening be produced. Once L has been determined as a constant for a given isotope, emulsion and conditions of development, this equation will allow the determination of the exposure time for any tissue section containing the isotope in any measurable activity, irrespective of the type of radiation emitted or the density of blackening corresponding to L. In this presentation, A_0 is expressed in terms of microcuries per cm.^{2}, L in microcuries destroyed per cm.^{2} (μcd/cm.^{2}).*

In this study, A_0 was determined by comparison with a known quantity of radioelement, by means of standard procedures. Thus Figure 1 shows a lead-shielded Geiger-Müller counter, where the activities of the tissue sections were measured. The tube is mounted horizontally and the shield is provided with a drawer as shown in (*a*). The drawer contains a depression, into which a block of wood is fitted. The block has a groove into which glass slides

* A microcurie is the amount of isotope disintegrating at the rate of 3.7×10^4 atoms per second.

* Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.
† This paper is based on work done under contract N6 O.R.I.-99, Task Order No. 1, with the Office of Naval Research.

supporting the tissue sections are mounted in reproducible position. When completely assembled, as shown in (*b*) and (*c*), the tissue section is directly underneath the sensitive volume of the counter, at a distance of about 1 inch. By drying a small, known volume of a solution containing a known activity, on a glass slide similarly placed, one can calibrate the tube in terms of counts/minute/microcurie* and obtain A_0 for the tissue section in question.

In order to determine L for equation (1), filter paper (Munktell's number ∞) impregnated with radioactive isotopes was used. Large pieces were dipped into solutions of I^{131} or P^{32}, allowed to dry, trimmed at the edges and then cut into 1 centimeter

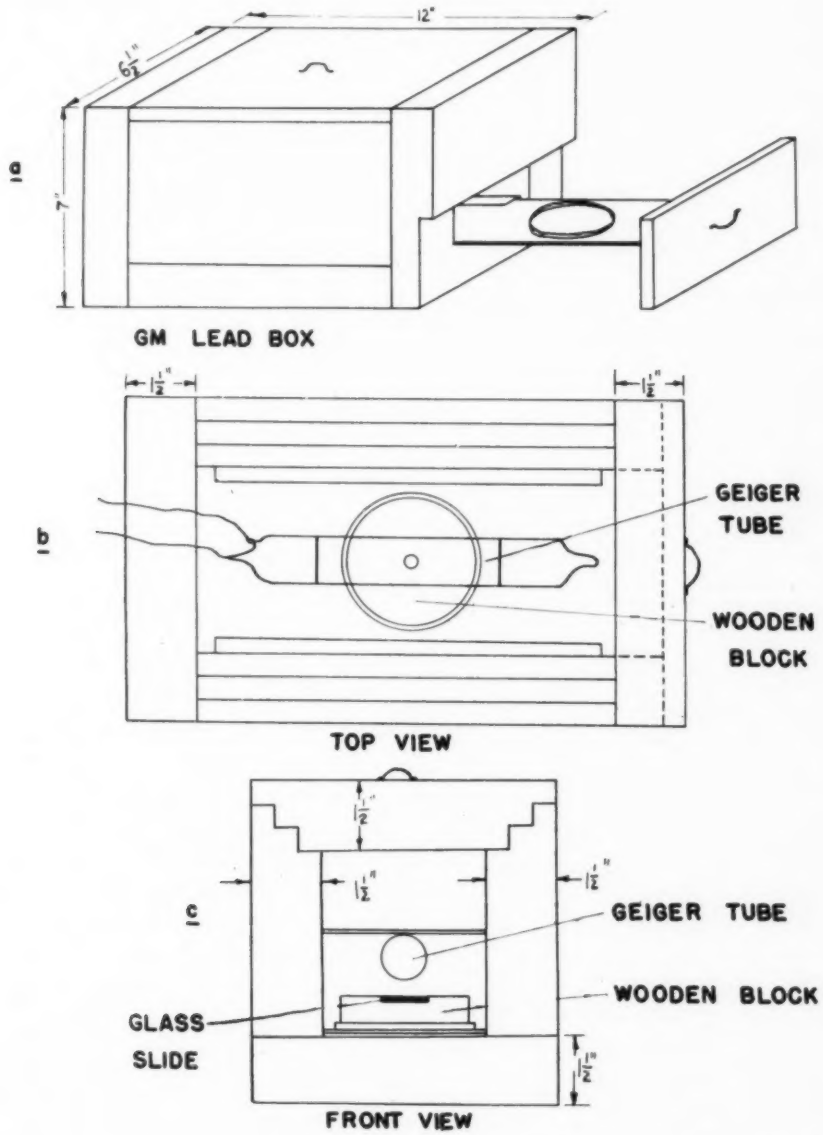

Fig. 1. Views of the apparatus used to measure the radioactivity of tissue sections.

* The I^{131} calibration was based on its gamma-ray output (2.65 roentgens per millicurie-hour at 1 cm.); the P^{32} calibration was based on the average value of an intercheck carried out in April, 1946, by the National Bureau of Standards, University of California (Berkeley), Massachusetts Institute of Technology, and the United States Atomic Energy Commission (Oak Ridge).

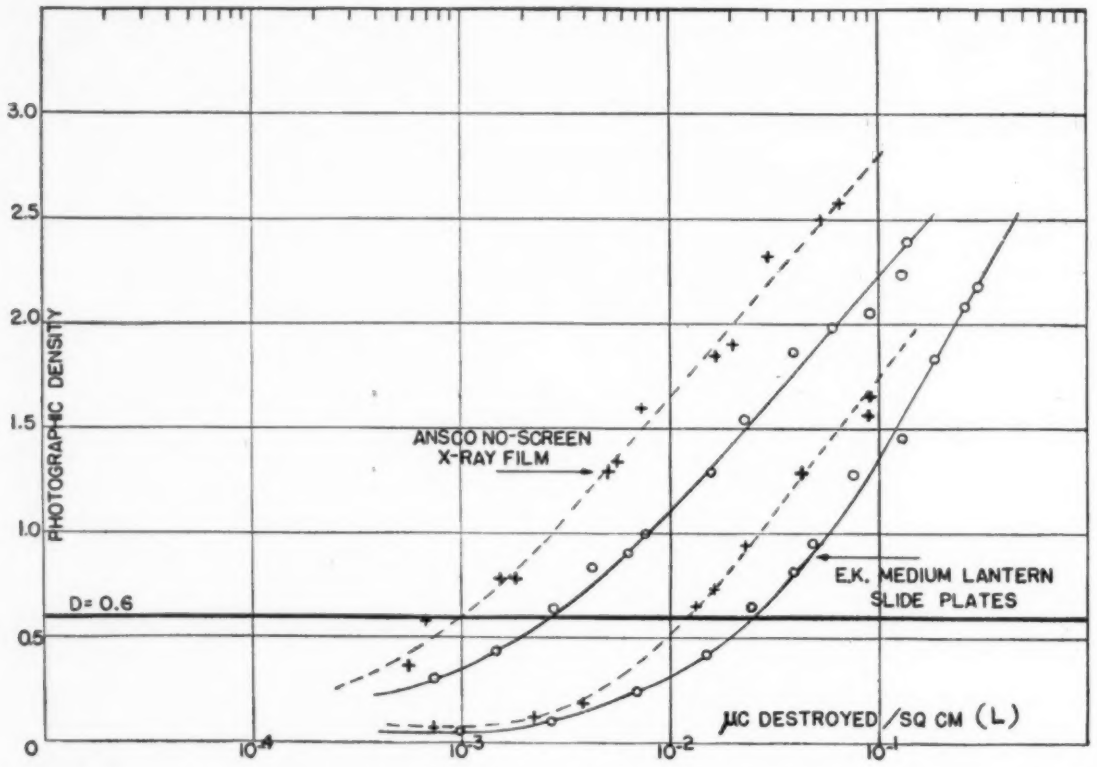

Fig. 2. Photographic density as a function of microcuries destroyed per sq. cm., for 2 types of emulsion Broken lines—P^{32}; solid lines—I^{131}.

squares. These were placed on glass slides and their activities measured. After this, they were placed on Eastman Kodak medium lantern slide plates or Ansco no-screen x-ray films, each square being held down with a brass weight, placed on top of the glass. The squares were exposed for different lengths of time (one hour to seven days). After exposure, the plates and films were developed and the photographic densities were measured with a photoelectric densitometer. The relationship between densities and μcd/cm.^{2} for all 4 cases is shown in Figure 2. The curves to the right refer to I^{131} and P^{32} on the lantern slide plates and those to the left refer to the same isotopes on roentgen film. Table 1 shows the values of L corresponding to a density of 0.6 which was chosen arbitrarily as a standard. It is seen that, for both isotopes, the sensitivity of the roentgen film is about 10 times that of the lantern slide plates.

Table I

Values of L in μcd/cm.^{2} for D = 0.6

Isotope	Emulsion	L
I^{131}	Eastman Kodak medium lantern slides	0.025
	Ansco No-Screen x-ray film	0.0027
P^{32}	Eastman Kodak medium lantern slides	0.0120
	Ansco No-Screen x-ray film	0.0010

Since the beta-ray spectra of these elements are continuous and therefore include rays of low penetrating power, it was thought advisable to ascertain whether the absorption in the filter paper (6.2 mg/cm.^{2}) was appreciable. This was done by exposing the photographic emulsion to two and three superimposed layers of filter paper containing approximately the same quantity of isotope per unit surface. It was found that the *photographic densities* produced by

the double and triple layers were the same densities that would have been produced (as shown by the curves of Figure 2) had these multiple activities been confined to only one layer of paper. This showed that practically all the radiations reached the emulsion. This was confirmed by exposing, for the same lengths of time, one slip of paper and a set of two slips, each of half the activity per cm.^{2} of the one, the two being superimposed. In this case, the density produced by the set was equal to the density produced by the one slip, within the limit of experimental error. It was concluded, therefore, that the filter paper procedure may be safely used to determine L for tissue sections of a thickness at least as great as 6.2 mg/cm.^{2} ($\sim$62 μ) when the isotopes in question are I^{131} or P^{32}. One could not expect this to apply however, to elements such as C^{14} and S^{35}, whose beta rays have very much less energy.

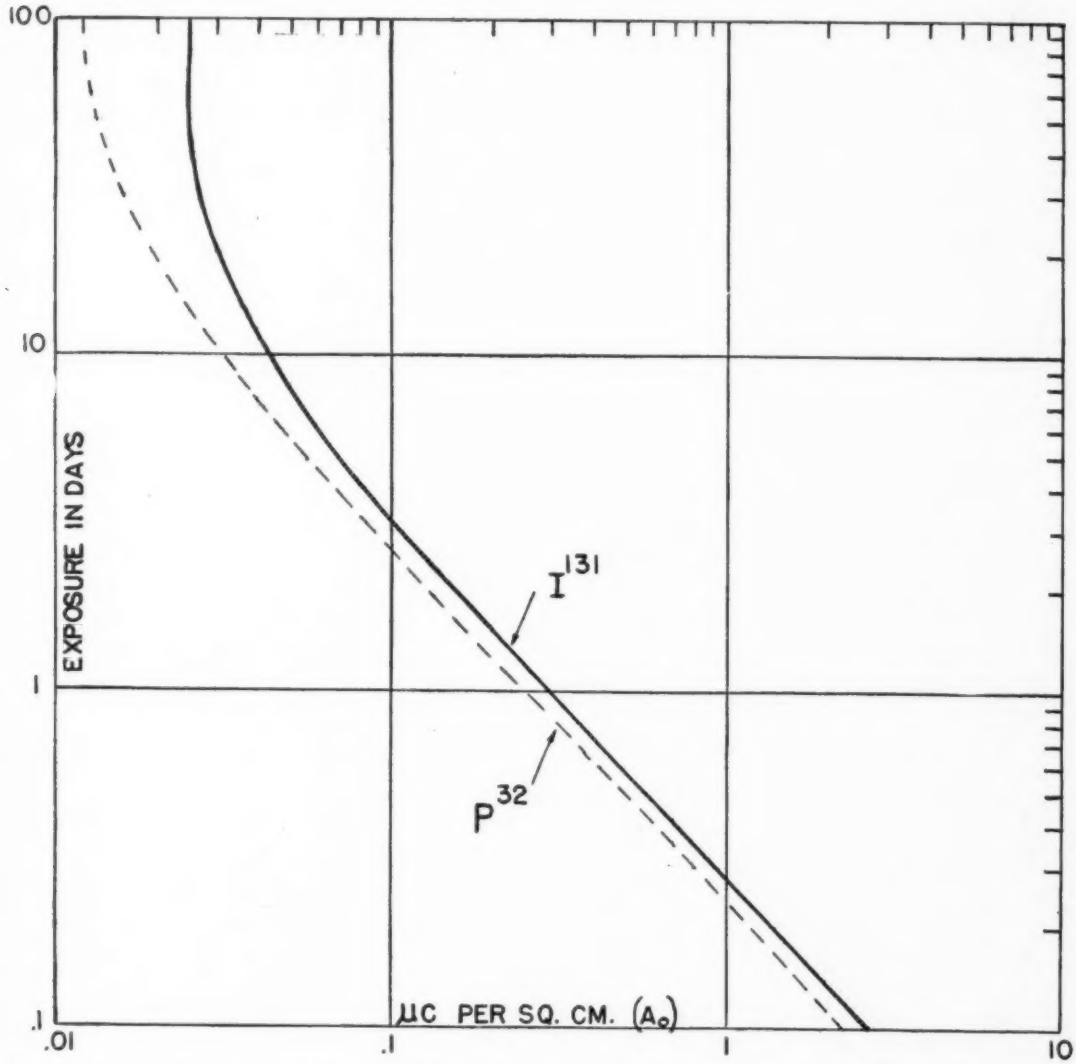

FIG. 3. Exposure time as a function of initial activity, for Eastman Kodak medium lantern slide plates and photographic density of 0.6.

By substituting the values of L in equation (1) a relationship between the exposure time t and the initial activity A_0 is obtained. In Figure 3 this was done for I^{131} and P^{32}

on medium lantern slide plates and D = 0.6. The required value of the exposure time can be read directly on the ordinate scale once the activity of the tissue section in $\mu c/cm.^2$ is known. Figure 4 shows similar curves for the no-screen x-ray film.

graph is made. The latter, however, need not be of optimal exposure and usually can be guessed by visual inspection of the section. In the case of tissue sections cut from the thyroid gland, the factor of uncertainty due to inhomogeneous distribu-

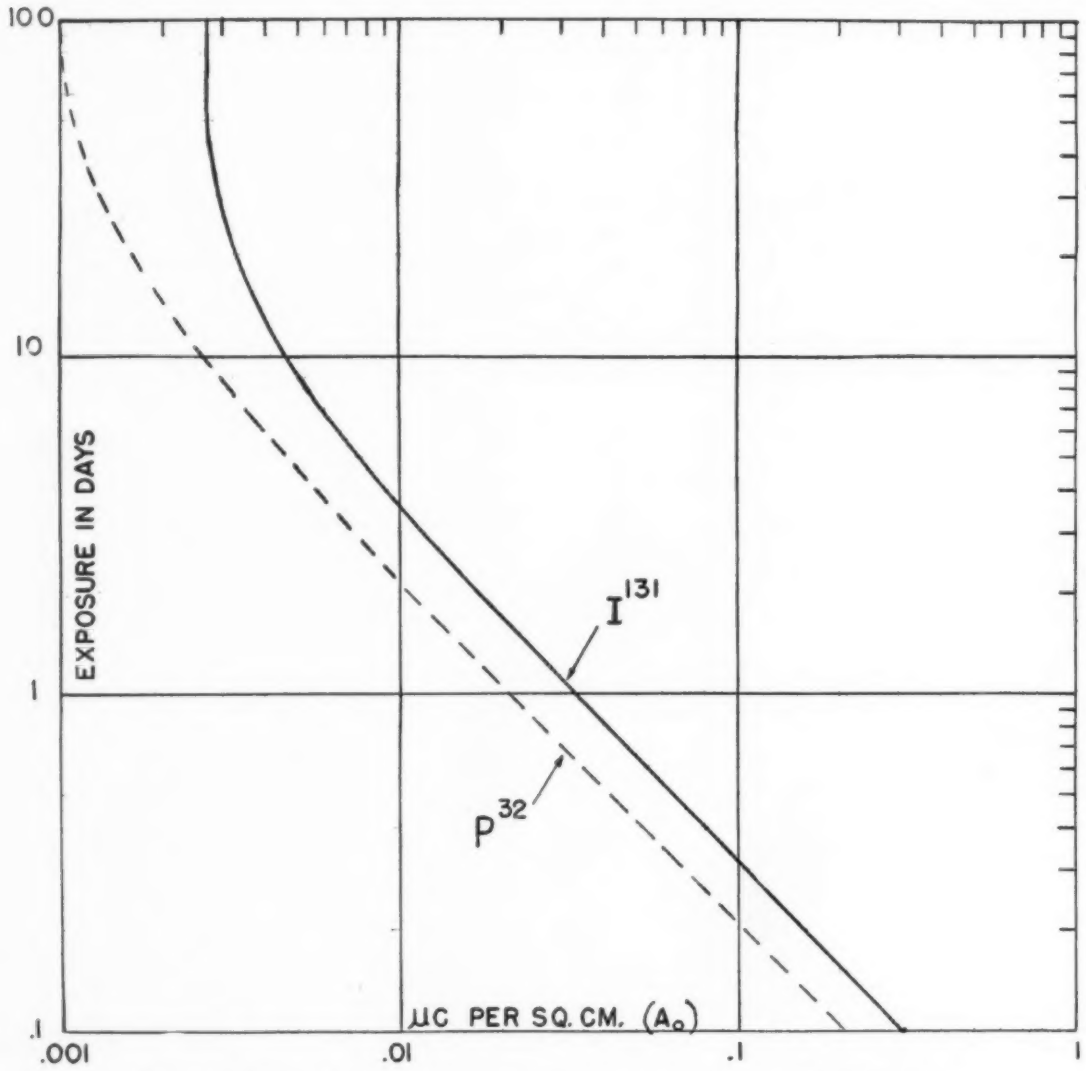

FIG. 4. Exposure time as a function of initial activity for Ansco no-screen x-ray film and photographic density of 0.6.

It must be recognized, however, that the above values of the exposure time are based upon a homogeneous isotope distribution. Therefore, in calculating A_0 for a tissue section, one must divide the measured activity by the area over which the isotope is actually spread. Obviously this cannot be known until a test radioautotion of radioactive iodine can be reduced to a minimum by taking into account that iodine is confined predominantly to the colloid. The ratio of the colloid to follicle volume according to Stein[6] is close to 1/4.*

* This figure, obtained by complete serial sectioning of 199 follicles of a normal human thyroid, seems more representative than any other based on mean follicular diameter and mean acinar cell height.

If we assume, moreover, that the area occupied by interfollicular tissue is about equal to the total area occupied by follicles, an overall factor of about 8 is obtained. Thus in the case of sections made from normal or adenomatous tissue of the thyroid gland, one should multiply the apparent activity of unit area (as obtained by counter measurements and over-all area of the tissue section) by 8 in order to obtain A_0 and hence the exposure time from the graph of Figure 3. In our laboratory 3 sections are exposed routinely for different lengths of time leading *up* to this graphical value.*

In the case of sections made from thyroid cancers, the ratio of total area to colloid area can be much larger because there may be only isolated groups of follicles, surrounded by large areas of much less differentiated tissue. However, if one estimates what fraction of the entire area appears to be follicular, multiples this factor by 8, and exposes 3 sections up to the maximum time given by the graph, the results will be quite satisfactory. Figure 5 shows a radioautograph made under these conditions. Here the area containing follicles almost completely surrounds the central non-follicular area. This central portion has large empty spaces in addition to undifferentiated tumor tissue. The estimated ratio of the outside rim to the total area was about 1/2. The over-all factor was then 8×2 or 16. Multiplying the apparent value of $\mu c/cm.^2$ by 16, we obtain $A_0 = 0.036$; therefore the required exposure time was fourteen days. Figure 5 is the result of a thirteen day exposure. If A_0 falls below the minimum required, i.e. the value of L, we have been routinely exposing sections for two to three weeks and have obtained at times evidence of I^{131} confined to minute portions of the section.

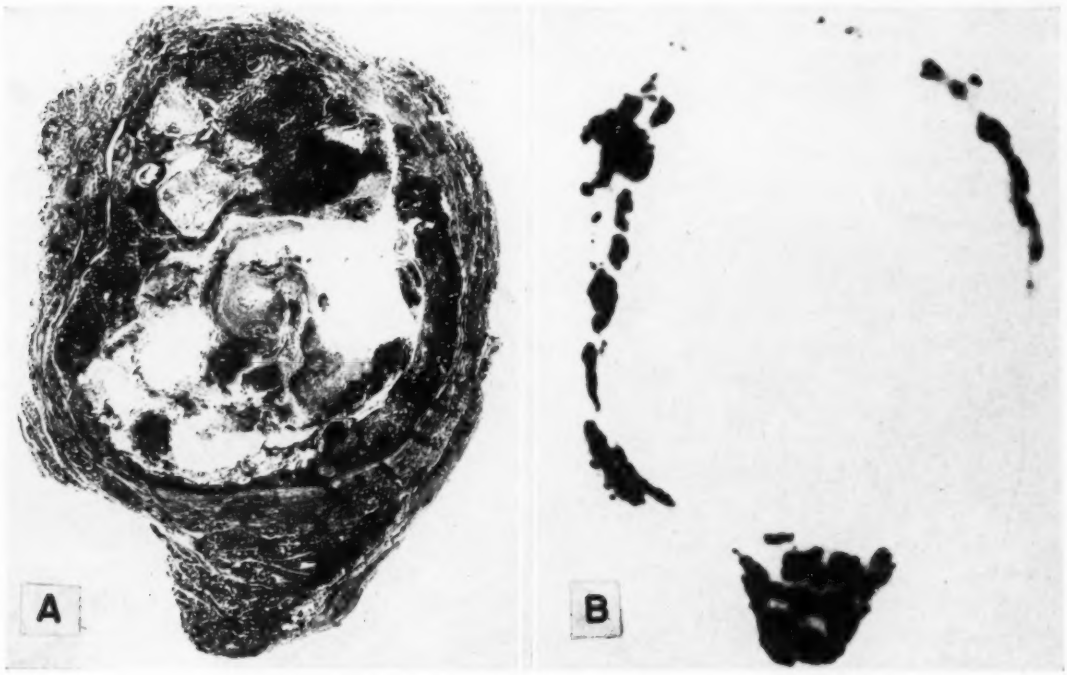

Fig. 5. Tissue section (*A*) and radioautograph (*B*) of a Hürthle cell adenocarcinoma. Adjacent thyroid tissue almost completely surrounds the central, tumor area.

II. THE TISSUE DOSE

The doses (in equivalent roentgens) which must be given to tissues to obtain adequate radioautographs can be estimated

* Theoretically only two sections should suffice. The third one is exposed routinely to ascertain whether artifacts might be present in the final product.

from the given values of L and the thickness of the specimen. Values of the initial concentration less than L are insufficient to obtain the given photographic density.

If the isotope is administered with the purpose of investigating the deposition of isotopes in the small aggregates of cells, the tissue sections must be thin, usually not over 10 microns on the average. The volume of such a section is obviously at most 0.001 cm.^{3} for each cm.^{2} of surface. For the case of I^{131}, therefore, the minimum tissue concentrations necessary to obtain radioautographs of density 0.6 are 25 or 2.7 μc/gram according to whether the plates or the films are used. These concentrations refer to those portions of the tissue in which I^{131} is deposited, the average for the gland being 1/8 of these values, i.e. 3.1 and 0.34 μc/gram respectively. Since 1 microcurie of I^{131} destroyed per gram of tissue exposes the latter to 144 e.r.,[4] the concentrations of 25 and 2.7 μc/gm. correspond to maximal tissue doses of 3,600 and 390 e.r. (or "average" doses of 450 and 49 e.r.) respectively. The use of lower photographic densities would offer some advantage since a density of 0.25 on film gives $L = 5 \times 10^{-4}$ μcd/cm.^{2} (see Fig. 2) and a corresponding maximal dose of 72 e.r. and an average dose of 9 e.r. over the gland. The above mentioned figures need downward corrections of the order of 10 to 30 per cent in order to take account of the elimination of I^{131} from the thyroid. As far as biological effect is concerned they cannot be considered a priori wholly equivalent to the same number of roentgens of x-rays. Their magnitudes, however, do pose the question as to whether radioautography of thyroid tissue as practiced at present should be limited only to human cases in which radiation therapy with I^{131} or total thyroidectomy is contemplated. Similar calculations for the case of thin sections containing P^{32} show that the minimum tissue dose necessary for a density of 0.6 in *films* requires concentrations of 1.0 μc/gram in 10 μ sections. Since 1 microcurie of P^{32} destroyed per gram of tissue exposes the latter to 885 e.r., the maximal tissue dose would be $1.0 \times 885 = 885$ e.r.—obviously too high a dose for an isotope so widely distributed in the human body. It is evident that radioautographs with P^{32} could be attempted only in properly dosed terminal cases. A lowering of the photographic density to 0.25 will reduce the above values also to 1/5 (see Fig. 2) and hence should make barely possible the production of radioautographs from some highly selective tissues of patients undergoing therapy.

The methods of Belanger and Leblond[2] and of Evans[3] should be considered at this point. Essentially these investigators attach the tissue sections to the photographic emulsion without glass slide support. Other conditions (type of emulsion, development, etc.) being equal, these techniques should require slightly higher exposures because the scattering effect is less than that for the method described above. The increase, however, cannot be of much practical importance.

It should be noticed from the values given above, that the tissue doses necessary for thin section radioautography with P^{32} are higher than those required for I^{131}. This is a consequence of the fact that the sensitive material of the film or plate utilizes a smaller fraction of the beta-ray energy emitted by P^{32}—the more penetrating of the two—whereas the tissues would, on account of their bulk, absorb practically all in both instances.

The above considerations suggest that the use of faster photographic material is needed if this technique is to find wide clinical application. The graininess of the faster films cannot be considered a drawback because the limiting factor in the magnification of useful detail rests, for the vast majority of radioelements, on the length of their beta-ray tracks. As a matter of fact graininess may well be considered an advantage in many cases since it precludes confusing the photographic with the histological image under the field of vision of a microscope.[2,3]

When the *distribution* of the radiation

within a tissue, rather than the *localization* of the isotope itself, is being investigated by radioautography, the thickness of the tissue section should be about equal to or larger than the length of the track of the most energetic beta particle emitted by the isotope. For this technique the restrictions mentioned above do not apply. Preliminary investigations into this problem indicate that, for radioactive iodine, the concentration can be reduced by a factor of 30, if a block of tissue instead of a thin section is exposed. It is hoped to consider this problem separately at length and report on it later.

It is of some interest to calculate the number of beta particles, which, incident on a unit area of photographic emulsion, will produce an image of a certain density. Limiting ourselves to the lantern slide plates, we recall that the number L of microcuries destroyed per cm.^{2} necessary to produce a density of 0.6 is $L=2.5\times10^{-2}$ for I^{131} and $L=1.2\times10^{-2}$ for P^{32}. Moreover, the number of beta particles emitted per microcurie destroyed is $N_0=2.3\times10^9\times T$ where T is the half life of the isotope in days.* We obtain therefore $L\times N_0=4.6\times10^8$ beta rays per square centimeter in the case of I^{131} and 4.0×10^8 beta rays per square centimeter in the case of P^{32}. These values are presented herein with the purpose of indicating only their order of magnitude because under the experimental conditions, a significant amount of scatter from glass plates and slides takes place. It is worthy of notice, however, that Baker *et al.*[1] using a monoenergetic (212 kv.)† beam of electrons directed normally upon the same type of plates obtain a photographic density of 0.6 when the beam intensity is 1.13×10^9 electrons per cm.^{2} This discrepancy, in view of the many factors involved in the experimental conditions, is to be regarded as small.

* For this problem, we may assume that one-half the total number of particles are emitted in the direction of the photographic emulsion.

† This energy is close to the average energy, 205 kv. of the beta rays from I^{131}.

SUMMARY

A simple method has been described, whereby the uncertainty in exposure time for the production of satisfactory radioautographs is reduced. The graphs correlating activity of tissue section and exposure time necessary to obtain satisfactory results are presented for I^{131} and P^{32}.

An estimate of the radiation dose delivered to tissue shows that the use of the fastest films is indicated and that in general the radioautographic technique with thin tissue sections should be limited to patients undergoing therapy with radioelements.

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REFERENCES

1. Baker, R. F., Ramberg, E. G., and Hillier, J. The photographic action of electrons in the range between 40 and 212 kilovolts. *J. Applied Physics*, 1942, *13*, 450.
2. Belanger, L. F., and Leblond, C. P. A method for locating radioactive elements in tissues by covering histological sections with a photographic emulsion. *Endocrinology*, 1946, *39*, 8.
3. Evans, T. C. Radioautographs in which the tissue is mounted directly on the photographic plate. *Proc. Soc. Exper. Biol. & Med.*, 1947, *64*, 313.
4. Marinelli, L. D., Quimby, E. H., and Hine, G. J. Dosage determination with radioactive isotopes. II. Practical considerations in therapy and protection. Am. J. Roentgenol. & Rad. Therapy, February, 1948, *59*, 260–281.
5. Morgan, R. H. Reciprocity law failure in x-ray films. *Radiology*, 1944, *42*, 471–479.
6. Stein, H. B. The volume of the colloid in follicles of a normal human (Bantu) thyroid gland. *Am. J. Anat.*, 1940, *66*, 197–211.

THE EFFECT OF ADRENAL CORTICAL INJURY ON THE TOXICITY OF ROENTGEN RAYS*

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THE well known sensitivity of the gonads to roentgen irradiation, coupled with the known interrelationships between the gonads and the adrenal cortices, ably presented in a recent review by Parkes,[1] made it desirable to study the sensitivity of the adrenals to irradiation and the possible effect of that sensitivity upon the survival of exposed animals. Since this experiment was performed a careful search of the literature, but recently available to us, has revealed several pertinent papers of interest which it would appear justifiable to review briefly and correlate since this has not previously been done.

Several investigators have suggested that irradiation sickness might reflect injury to the adrenal cortices.[2–6] Presumably this hypothesis was suggested to these authors not only because of the striking parallelism between the symptoms of Addison's disease and irradiation sickness (Weichert[7]) but also because of evidence of adrenal changes after irradiation. The history of these latter studies has been reviewed by Clark[8] and more recently by Raab and Soule.[9] The earlier reports that the adrenals were quite sensitive to irradiation were not confirmed by Desjardins,[10] Frey,[11] and Engelstad and Torgersen[12] who concluded the adrenals were no more sensitive than other tissues. The careful histological studies of Frey[11] negate many of the earlier clinical impressions. A loss of adrenal cortical lipoid was observed in the victims of an acute radiation death in Japan according to Warren's report[13] but this may have been evidence only of a general "alarm reaction."[14] Hirsch[15] in 1922 apparently first used an adrenal extract for the treatment of irradiation sickness and reported good results. In 1942 Weichert,[7] in the only other report of its use that we have found, reported the effect of the administration of 2.5 to 5 mg. of percorten and cortiron, preparations of the adrenal steroids, given partly prophylactically and partly therapeutically to patients exposed to roentgen rays. He noted that the 25 patients so treated were, with few exceptions, improved, especially if the treatment was given prophylactically. It would be sanguine to expect that an agent so universally destructive to biological tissues as roentgen rays could have its lethal effects very markedly diminished by the protection of a single tissue, even though significant differences in the sensitivity of various tissues have been long recognized. Nonetheless, there would be definite clinical application for any therapeutic agent which would permit in a given situation an augmentation of the dose of therapeutically administerable roentgen radiation by raising the threshold dosage above which irradiation sickness and intolerable side effects would appear. This experiment was designed to test the hypothesis that a preferential injury by roentgen irradiation of the adrenal cortices might be a major limiting factor in the patient's toleration of roentgen rays. Leblond and Segal[16] reported that adrenalectomized rats were more susceptible to the lethal action of roentgen rays but they used rats whose adrenals had been removed from two to five days before irradiation. Since no mention was made of replacement therapy one must conclude these rats were already far from normal.

METHOD

Two series of 25 white male rats each (Wistar strain) were exposed in the follow-

* This paper is based on work performed under Contract Number W-7401-eng-49 with the Manhattan Project for the University of Rochester, Rochester, New York. Present address: Department of Pharmacology, Research Division, Ciba Pharmaceutical Products, Inc., Summit, New Jersey.

ing manner to irradiation by roentgen rays: (1) the "protected" rats were covered over the adrenal area of the back with a lead strip 1 inch wide, maintained in that position by confining the rats in cellophane cones; (2) the "unprotected" rats had two ½ inch lead strips shielding them, one over the upper chest and the other over the lower abdomen. Since the 1 inch strip protected the lower chest and upper abdomen, the two ½ inch strips were placed as described so that they might protect approximately equivalent amounts of like tissue. The technical factors of the exposure were as follows: 250 kv., 15 ma.; 24 inch target skin distance, 660 r total dose, 19.6 r per minute output, an exposure of 33 minutes 40 seconds.

The assumed L.D.$_{50}$ for the rats was 550 r.[17] Since the strips were estimated to protect about 20 per cent of the exposed animal, the actual dose was augmented by one-fifth so that 660 r was administered to each animal.* All 50 of these rats survived for thirty days after the exposure save 3 of the "unprotected" series which died twelve, twelve, and sixteen days after exposure. Twenty-nine days after the first exposure the same two groups of rats were similarly exposed again but this time to 880 r, since the results after the first exposure had indicated that the assumed L.D.$_{50}$ was too low. The technical factors of exposure were as follows: 250 kv., 15 ma., 24 inch target skin distance, 880 r total dose, 21.9 r per minute output, an exposure of 40 minutes.

The filters used for both these exposures were the aluminum parabolic plus 0.5 mm. copper.

After this exposure 2 of the "protected" animals died, one on the fourth and one on the twelfth day after exposure. Seven of the "unprotected" animals died on the third, ninth, sixteenth, seventeenth, twenty-fourth, twenty-sixth and thirtieth days after this exposure, after which the remaining animals were destroyed. In the "protected" series, 3 rats were obviously in poor health as evidenced by a roughened fur and obvious weight loss. In the "unprotected" series 6 rats were in poor condition.

Mr. David Tiedeman very kindly analyzed the foregoing data statistically and submitted the following values: $\chi^2 = 5.3728$; $P = 0.0205$. It is thus apparent that the measure of protection afforded in these experiments could have resulted from chance in only one trial out of fifty.

DISCUSSION

If one accepts the hypothesis that the major factor decreasing the toxic action of roentgen rays in this experiment was the protection accorded the adrenals, admittedly a debatable assumption in view of the literature earlier reviewed, then certain speculations are suggested. (It is at least reasonable to postulate that the adrenal cortical output per day was decreased in the "unprotected" animals.) White[18] reported that small doses of roentgen rays would produce disruptive changes in the lymphocytes of mice and that the production of equivalent changes in adrenalectomized mice required a twenty-fold increase in the dose of radiation. Dougherty, White and Chase[19] have previously reported evidence that nonspecific poisons can cause a destruction of lymphocytes in animals whose adrenals are intact. It seems possible that the markedly increased activity of the adrenal cortices after injury may lead, among other changes, to an extensive breakdown of lymphocytes and that the products of that breakdown play a major role in subsequent tissue repair. Thus undue adrenal injury might prevent the release of adequate amounts of hormones for a sufficient length of time although it is also possible a suitable dose might cause the release of such large amounts of hormone in answer to the increased demands as to exceed the capacity of the lymphoid tissue to respond. Since competent investigators have not been able to agree on the sensitivity of the adrenal cortices to the effects of roentgen radiation, the most reasonable explanation would be the assumption that

* Obviously an approximate correction because of such indeterminable variables as scattering, and so forth.

unknown variables are altering the results in an inconstant manner. All these seemingly unrelated facts might be explained by the hypothesis that the general tissue damage caused by roentgen rays requires the protein products of lymphoid tissue for repair and that these proteins are made available by adrenal cortical activity. The breaking of any of the three links in this chain—adrenal cortical activity, availability of lymphoid proteins, and actual tissue repair—would sharply limit the organism's capacity for recovery from the damage caused by a given dose of roentgen rays. Such a concept would accord well with Spiegelman and Kamen's[20] recently advanced hypothesis, if one assumed the self-duplicating nucleoprotein replicas and not the genes were primarily affected. The latent period between exposure to roentgen rays and the onset of symptoms could then be viewed as the interval during which the replicas and the enzymes derived therefrom were exhausted. One could then proceed on the hopeful assumption that the supplying of adequate raw materials during that latent period might permit the organism to restore homeostasis within the damaged cells. The perhaps more probable hypothesis that irreversible damage to the cell's genes had occurred would allow us no good method of remedial attack in the light of our present knowledge. Albeit, even if we accept this latter hypothesis, it might still be argued that supplying to the tissues adequate raw materials would accelerate the multiplication of undamaged cells.

If one accepts the foregoing reasoning, it would appear that potentially fatal exposure to roentgen rays might theoretically respond favorably to adequate amounts of adrenal cortical hormones and transfusions of lymphocytes, on the assumption that that would allow sufficient tissue repair to permit the organism to restore homeostasis. A practical approach might be the administration of the proteins, and so forth, derived from lymphocytes plus the adrenal cortical hormone. The single experiment herein reported is of little value but the courses suggested by it are being pursued.

The report of Lofstrom and Nurnberger[21] came to our attention since this paper was written. They secured dramatic results in the treatment of irradiation sickness by the injection of benadryl, an antihistaminic drug. Segal's[22] report that the histamine concentration in the blood of irradiated patients is increased may offer a reasonable experimental basis for such treatment. It would seem in conclusion as though a multiple therapeutic approach to the treatment of irradiation sickness might be justified because of the multiple nature of the roentgen ray's destructive effects. A combination of an antihistaminic drug, adrenal cortical hormones, liver extract and the B vitamins might give even better therapeutic results than any single agent thus far administered. The author hopes this idea may be evaluated by interested clinicians with the proper facilities for such a study.

SUMMARY

Evidence is presented suggesting that rats whose adrenals are protected from roentgen irradiation are less susceptible to its lethal effects than rats receiving equivalent doses but not so protected. The possible relation of the adrenal-lymphoid system to irradiation sickness and the lethality of roentgen radiation has been discussed.*

The author thanks Mr. Francis Bishop for arranging the exposures in this experiment, and Miss Mildred Taylor and Mrs. Florence Van Slyke for technical assistance.

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REFERENCES

1. Parkes, A. S. Adrenal-gonad relationship. *Physiol. Rev.*, 1945, *25*, 203–254.
2. Heineke and Perthes. Die biologische Wirkung der Röntgen- und Radiumstrahlen. From H. Meyer's Lehrbuch der Strahlentherapie, Bd. I.

* Since this paper was written, Ellinger[23] has reported the value of desoxycorticosterone in preventing roentgen-ray induced hepatic changes in rats. He suggests that it acts by opposing the effects of histamine but it would appear to us that it can oppose the action of histamine only in the sense that the "general adaptation syndrome" is the organism's response to many toxic materials.

3. Narat. *J.A.M.A.*, 1922, *79*, 1681–1684.
4. Thaddea, S. Klinische Erscheinungsformen der Nebenniereninsuffizienz. *Klin. Wchnschr.*, 1940, *19*, 145–151.
5. Steinberg, S. S. Irradiation sickness. Am. J. Roentgenol. & Rad. Therapy, 1942, *47*, 56–65.
6. Jenkinson, E. L., and Brown, W. H. Irradiation sickness; hypothesis concerning the basic mechanism and a study of the therapeutic effect of amphetamine and dextro-desoxyephedrine. Am. J. Roentgenol. & Rad. Therapy, 1944, *51*, 496–503.
7. Weichert, Ursula. Die Behandlung des sogenannten "Strahlenkaters" mit desoxycorticosteron. *Strahlentherapie*, 1942, *71*, 127–138.
8. Clark, G. L. Effects of x-radiation on cell structure and growth; general survey of radiobiology, *Cold Spring Harbor Symp., Quant. Biol.*, 1934, *2*, 249–263.
9. Raab, W., and Soule, A. B., Jr. Rationale and results of roentgen treatment of adrenal glands in angina pectoris. Am. J. Roentgenol. & Rad. Therapy, 1944, *51*, 364–377.
10. Desjardins, A. U. Effect of irradiation on suprarenal gland. Am. J. Roentgenol. & Rad. Therapy, 1928, *19*, 453–461.
11. Frey, H. Experimentelle Untersuchungen über die Röntgensensibilität der Nebennieren. *Acta radiol.*, 1928, *9*, 23–53.
12. Engelstad, R. B., and Torgersen, O. Experimental investigations on effects of roentgen rays on suprarenal glands in rabbits. *Acta radiol.*, 1937, *18*, 671–687.
13. Warren, S. Pathologic effects of an instantaneous dose of radiation. *Cancer Research*, 1946, *6*, 449–453.
14. Selye, H. General adaptation syndrome and diseases of adaptation. *J. Clin. Endocrinol.*, 1946, *6*, 117–230.
15. Hirsch, H. Zum Problem des Röntgenkaters. *Strahlentherapie*, 1923, *14*, 679–684; also, *Deutsche med. Wchnschr.*, 1922, A-646.
16. Leblond, C. P., and Segal, G. Differentiation between the direct and indirect effects of roentgen rays upon the organs of normal and adrenalectomized rats. Am. J. Roentgenol. & Rad. Therapy, 1942, *47*, 302–306.
17. Potter, J. C. Biological effect of roentgen rays of long and short wavelength on the totally irradiated rat. *Radiology*, 1941, *37*, 724–725.
18. White, A. Factors influencing serum globulin formulation. Symposium on Body Proteins, University of Buffalo, Sept., 1946.
19. Dougherty, T. F., Chase, J. H., and White, A. Pituitary-adrenal cortical control of antibody release from lymphocytes. Explanation of the anamnestic response. *Proc. Soc. Exper. Biol. & Med.*, 1945, *58*, 135–140.
20. Spiegelman, S., and Kamen, M. D. Genes and nucleoproteins in synthesis of enzymes. *Science*, 1946, *104*, 581–584.
21. Lofstrom, J. E., and Nurnberger, C. E. Irradiation sickness; histamine effect treated with benadryl. Am. J. Roentgenol. & Rad. Therapy, 1946, *56*, 211–219.
22. Segal, G. Variations du taux d'histamine chez des malades soumis à un traitement par rayons X. *Compt. rend. Soc. de biol.*, 1939, *131*, 1079–1080.
23. Ellinger, F. Protective action of desoxycorticosterone acetate against x-ray-induced liver changes. *Science*, 1946, *104*, 502–503.

EXPERIMENTAL STUDIES ON THE TOXICITY OF BETA-(4-HYDROXY-3,5-DIIODOPHENYL)-ALPHA-PHENYL-PROPIONIC ACID (PRIODAX)*

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DICK and Wallace[1] in 1928 reported on the toxicity of tetraiodophenolphthalein to pancreatic tissue. The dye, widely used in cholecystography, is absorbed from the gastrointestinal tract and excreted largely by the liver but partly by the kidneys. From their experiments on cats and rabbits Dick and Wallace concluded,

> It may thus be inferred that in cases of cholelithiasis, in which stones are present in the common duct and the conditions are otherwise favorable for the retrojection of bile in the pancreas, the danger of acute pancreatitis occurring will be much greater if the regurgitated bile contains the phenolphthalein salt.
>
> In obstructive jaundice the normal route of elimination of the drug is unavailable, and small quantities are excreted in the pancreatic juice. In animals with experimental biliary obstruction, especially in rabbits, it was found that pathological changes occurred in the pancreas ranging from simple vascular congestion to hemorrhagic pancreatitis. The conclusion to be drawn from this is that there is risk of damage to the pancreas by the administration of the agent to jaundiced patients who have chronic obstructive lesions of the biliary tree.

Partially as a result of this warning many roentgenologists, internists and surgeons have been hesitant to use tetraiodophenolphthalein for cholecystography in the presence of obstruction to the extrahepatic biliary tract or in suspected pancreatitis.

In 1940 a new dye for cholecystography, beta-(4-hydroxy-3,5-diiodophenyl)-alpha-phenyl-propionic acid, was introduced. It was marketed abroad under the trade name biliselectan and later in America under the trade name of priodax. In this paper it will be referred to by the latter trade name.

The dye contains 51.5 per cent iodine by weight. Wasch[2] described it as being readily absorbed from the gastrointestinal tract through the portal circulation and excreted in part through the liver, the iodine being said to remain in organic combination as it passes through the body.

Modell[3] studied the pharmacology of priodax and found in cats that an intravenous injection of 75.0 mg. per kilogram of body weight produced picrotoxin-like, medullary convulsions. Postmortem examination revealed no abnormal findings except in one instance where pulmonary petechiae were found. When the drug was given orally to the cat, vomiting was not unusual, but this was controlled by the administration of morphine.* One hundred milligrams per kilogram of body weight given orally produced, in some instances, transient albuminuria. However, doses ten times as great, that is 1,000 mg. per kilogram did not affect phenolsulphonphthalein excretion, the non-protein nitrogen level in the blood, red cell count, red cell fragility or blood clotting time. There was no microscopic evidence of renal damage. In two of fifteen experiments one cat receiving 500 mg. per kilogram of body weight had a non-protein nitrogen level of 127 mg. per cent and another cat on the same dosage had cloudy swelling of the renal tubules.

Junkmann[4] showed that after the dye had been administered orally 50 per cent was excreted in the urine within twenty-four hours and that 61 to 83 per cent was excreted within seventy-two hours.

* In the cat stimulation of the central nervous system by morphine is not unusual and vomiting frequently results.

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Reports on the use of the drug in several thousand patients indicate its wide clinical use.[2,5–13]

In order to extend the studies made with the drug and to determine its effect on pancreatic tissue, additional experiments were undertaken in our laboratory. Cats and dogs were used as the experimental animals. Open drop ether, endotracheal ether or parenteral pentobarbital anesthesia was used. Priodax concentration was determined by adaptation of the method described by Chiray and others for iodine determinations.[14,15]

The Effects of Priodax on the Pancreas under Normal Conditions. Four normal dogs and two normal cats were used (Table I). Each dog was given 3.0 grams of priodax by mouth or stomach tube. This dosage was 400 to 500 mg. per kilogram of body weight. The cats were given 500 mg. of the dye by mouth, that is, approximately 250 mg. per kilogram. Twenty-four hours later laparotomy was performed; the pancreas was examined, and the iodine concentration in the gallbladder bile was determined (Table V). Grossly the pancreas appeared normal in each instance, and in two dogs where microscopic study was done, no histologic evidence of damage was found.

In the clinic an attempt was made to demonstrate possible pancreatic damage by serum amylase determinations on nine patients, each of whom had been given 3.0 grams priodax orally. No pancreatic disease, biliary obstruction or acute biliary disease was suspected in these patients. Roentgen visualization of the gallbladder occurred in each instance. Serum amylase concentration was determined by the modified Somogyi method as described by Elman.[16] Determinations were made immediately before the administration of the dye and again six to forty-eight hours following its administration. Duplicate determinations were made in each instance.

TABLE I

PRIODAX ORALLY TO NORMAL ANIMALS

Animal	No.	Dosage of Priodax per Kilogram of Body Weight	Time Elapsed between Administration of Drug and Examination of Pancreas	Appearance of Pancreas
		mg.	hrs.	
Cat	6	250	24	Grossly normal
	10	250	24	Grossly normal
Dog	400	1,096	22	Grossly normal
	986	500	24	Grossly normal
	918	450	48	Grossly and microscopically normal
	919	450	48	Grossly and microscopically normal

Table II indicates the results. There was no significant change in any instance.

The Effects of Priodax on the Pancreas in Cases of Obstruction of the Common Bile Duct. Six dogs and two cats were used for determination of possible injury to the pancreas in the presence of recent common duct obstruction. Using a sterile technique the common bile duct was doubly ligated. Eighteen hours later 0.5 to 3.0 grams of priodax (Table III) were given orally. Vomiting was not noted in any case after the drug was given.

A second laparotomy was performed on the first to seventh day following administration of the drug. In each instance a distended gallbladder and common duct were found. The pancreas was examined, and a section was taken for microscopic examination. Bile was then aspirated from the gallbladder and analyzed for iodine. Four of the dogs were sacrificed on the seventh

day after the dye was given and the pancreas re-examined.

The pancreas appeared normal except in two instances. Dog No. 432 had a slight subcapsular hemorrhage into the pancreas. This was found on the first day following the administration of the dye and was considered as probably due to the trauma of the first laparotomy. A section of the tail of the pancreas of Dog No. 1132 was obtained for microscopic study at the time of the common duct ligation. Four days after the dye was given, the pancreas appeared normal except for a single plaque of fat necrosis in the tail at the site of the previous biopsy.

TABLE II

EFFECTS OF PRIODAX (3.0 GRAMS ORALLY) ON SERUM AMYLASE OF PATIENTS

Patient	Serum Amylase Concentration Before Priodax Given	Time Elapsed between Administration of Dye and Second Analysis	Serum Amylase Concentration After Priodax Given
No.		hrs.	
1	140	24	145
	132		140
2	110	24	110
	110		100
3	110	24	100
	130		115
4	180	18	150
	170		155
5	88	18	110
	95		118
6	115	18	100
	125		118
7	150	6	165
	138		152
		24	165
			150
		48	152
			170
8	105	48	108
	102		96
9	88	6	115
	80		130
		12	100
			104

In order to control this observation biopsy was performed on the pancreas of one dog and one cat five days after ligation of the common bile duct. Grossly and microscopically the pancreas appeared normal.

Effects of Priodax Suspended in Physiological Saline Solution When Injected into the Pancreatic Duct. Seven dogs and four

cats were used in these experiments (Table IV). The major pancreatic duct was exposed by blunt dissection and ligated at its entrance into the duodenum. A No. 27 needle was then inserted into the pancreatic duct, and, in the dogs, 1.0 to 2.0 cc. of a suspension of 500 mg. of priodax in 100 cc. of physiological saline solution were injected pancreatic duct. There was no immediate reaction. Twenty-four hours later a specimen of the pancreas was taken. At that time the pancreas was normal except at the site of the ligation of the duct where there was hemorrhage and fat necrosis with some fat necrosis of the surrounding omentum. Forty-eight hours after the original oper-

TABLE III

PRIODAX ORALLY—OBSTRUCTION OF COMMON DUCT

Animal No.	Dosage of Priodax Per Kilogram of Body Weight	Concentration of Iodine in Gallbladder Bile	Time Elapsed between Administration of Drug and Examination of Pancreas	Appearance of Pancreas
	mg.	mg. %	Days	
Dog 1,132	350	25.0	4	Normal except for single plaque of fat necrosis
1,142	400	30.0	6	Normal
432	200	22.0	1	Slight subscapular hemorrhage
			7	Normal
433	150	10.0	3	Normal
			7	Normal
434	180	32.0	3	Normal
			7	Normal
435	150	5.0	3	Normal
			7	Normal
Cat 5	250	4.4	5	Normal
6	250	10.0	2	Normal

very slowly and under very low pressure into the duct. The duct was then ligated proximal to the needle so as to prevent leakage. Analysis of the suspension showed the amount of priodax injected to range from 0.8 to 4.2 mg. In cats 0.6 to 0.75 mg. of the dye in 0.5 cc. to 0.75 cc. of saline was injected into the duct.

Of the seven dogs, only one, No. 989, showed evidence of injury. This dog had 2.0 cc. physiological saline solution containing 4.0 mg. of priodax injected into the ation the dog died. Autopsy confirmed the pancreatic damage.

Several dogs were followed for two months without evidence of residual damage. The pancreas of the cats showed very slight damage. This consisted of a localized edema or fat necrosis at the site of the ligation.

As controls, 0.5 cc. to 2.0 cc. of physiological saline solution were injected into the main pancreatic duct of three dogs and two cats, and the duct was then ligated as

in the above experiments. Biopsy of the pancreas was then done twenty-four to seventy-two hours later. The pancreas appeared slightly edematous in several instances, and there was slight fat necrosis of the pancreas in one cat.

was then done twenty-four to seventy-two hours later. In no case was there leakage of bile from the gallbladder at the point of aspiration.

These experiments were repeated on three cats. Five hundred milligrams of

TABLE IV

PRIODAX IN PHYSIOLOGICAL SALINE SOLUTION

Animal No.	Amount of Priodax Injected	Amount of P.S.S. Injected	Time Elapsed between Injection of Dye and Examination of Pancreas	Appearance of Pancreas
	mg.	cc.	hrs.	
EXPERIMENTAL				
Dog 309	0.80	1.00	72	Normal
310	1.30	1.00	72	Normal
191	4.20	2.00	72	Normal
268	2.50	1.50	24	Normal
			72	Normal
989	4.00	2.00	24	Fat necrosis; hemorrhage; death of animal
			48	
1,091	4.20	2.00	72	Normal
1,093	3.60	2.00	24	Normal
Cat 3	0.60	0.50	96	Slight edema
4	1.20	0.75	72	Slight edema
8	0.80	0.50	48	Fat necrosis (one plaque)
9	0.75	0.50	48	Fat necrosis (one plaque)
CONTROLS				
Dog 80		1.00	24	Normal
81		1.50	72	Slight edema
84		2.00	72	Normal
Cat 12		0.50	72	Edema
14		0.50	72	Edema; slight fat necrosis

Injection of Gallbladder Bile Containing "Priodax" into the Pancreatic Ducts. Four dogs and three cats were used in this experiment. The dogs were given 3.0 grams of priodax orally. Approximately twenty-four hours later bile was withdrawn from the gallbladder, and 1.0 cc. was injected over a period of three minutes into the pancreatic duct as in the previous experiments. Analysis of the bile was done for iodine concentration (Table v). Biopsy of the pancreas

priodax were given orally. Twenty-four hours later 0.5 cc. of gallbladder bile was injected into the pancreatic duct as above.

In almost every instance there was marked injury of the pancreas, consisting of a polymorphonuclear exudate, edema and fat necrosis.

Controls. Four dogs and three cats were used as controls. By the previously described technique 0.5 cc. of bile was aspirated from the gallbladder and injected into

the pancreatic duct of each cat and 1.0 cc. into the duct of each dog. There was no leakage of bile from the gallbladder in any instance. As in the above experiment pancreatic injury was widespread. Fat necrosis, mild hemorrhage and polymorphonuclear exudate was found in almost every instance.

TABLE V

BILE CONTAINING "PRIODAX" INTO PANCREATIC DUCT

Animal No.	Amount of Bile Injected	Concentration of Iodine in Gallbladder Bile	Time Elapsed between Injection of Bile and Examination of Pancreas	Appearance of Pancreas
	cc.	mg. %	hrs.	
EXPERIMENTAL				
Dog 1,096	1.0	10.0	72	Slight inflammatory reaction
986	1.0	28.0	24	Fat necrosis
918	1.0	18.0	48	Inflammatory reaction
919	1.0	30.0	48	Normal
Cat 26	0.5	20.0	48	Fat necrosis
10	0.5	15.0	48	Fat necrosis
6	0.5	3.0	24	Normal
CONTROLS				
Dog 21	1.0		24	Fat necrosis; hemorrhage; death of
			48	animal
22	1.0		72	Normal
23	1.0		48	Slight fat necrosis
25	1.0		48	Inflammatory reaction
Cat 1	0.5		84	Fat necrosis
			96	Fat necrosis
2	0.5		84	Fat necrosis
			96	Fat necrosis
11	0.5		24	Fat necrosis; hemorrhage

DISCUSSION

These studies were undertaken in order to determine the safety of priodax in cholecystography in regard to the pancreas, (1) in uncomplicated cases of chronic cholecystitis, (2) in cases of obstruction to the extrahepatic biliary tract before marked jaundice, (3) in cases of stone in the common duct where reflux of bile into the pancreatic duct is a possiblity, and (4) following shortly after or during an attack of acute pancreatitis.

The results of the studies in the animals with unobstructed biliary tracts indicate that there was no damage to pancreatic tissue demonstrable by gross or histologic study. Amylase studies would not necessarily reflect pancreatic injury but are of interest since acute hemorrhagic pancreatitis has been reported following the administration of tetraiodophenolphthalein.

If, like tetraiodophenolphthalein, in the presence of acute extraheptic biliary obstruction a small part of the dye is excreted by the pancreas, there is little, if any, evidence by microscopic study that injury to pancreatic tissue results.

There is no evidence that priodax is excreated without some chemical alteration by the liver. Because of this possibility the concentration of the dye in gallbladder bile cannot be determined by the above methods, but instead the concentration of iodine is obtained. Duplicate iodine determinations did not indicate a consistent high degree of uniformity, and the iodine concentrations are, therefore, offered more for qualitative than quantitative purposes, that is, to prove the absorption of the dye and its presence in the bile. Evaluation of the results of the injections of priodax in physiological saline solution must, therefore, include the probability that this is not the form in which the dye reached the common bile duct.

Many investigators[17–22] have shown that the injection of bile into the pancreatic duct produces marked injury to the pancreas and frequently produces acute hemorrhagic pancreatitis. The results in the above experiments in which bile was injected into the pancreatic duct were therefore to be expected. No difference was found in the injury to pancreatic tissue resulting from the injection of bile and the damage produced by the bile containing the dye.

SUMMARY

1. Beta-(4-hydroxy-3,5-diiodophenyl)-alpha-phenyl-propionic acid, given orally to dogs and cats in doses of 250 to 500 mg. per kilogram of body weight, caused no gross or microscopic change in pancreatic tissue.

Serum amylase determinations immediately before and six to forty-eight hours after the administration of 3.0 grams of this dye orally to nine patients with unobstructed extraphepatic biliary tracts showed no significant change.

2. The dye, in doses of 150 to 400 mg. per kilogram of body weight, was given orally to dogs and cats following recent ligation of the common bile duct. Fat necrosis was found in only one dog, and this was at the site of a previous biopsy. In all other animals evidence of resultant damage was lacking.

3. A suspension of priodax in physiological saline solution, 0.5 cc. to 2.0 cc., was injected into the main pancreatic duct of dogs and cats. One dog died forty-eight hours after injection with acute hemorrhagic pancreatitis. Gross and microscopic study of the pancreas of the other animals showed little, if any, difference from the pancreas of the control animals which had been injected with equal amounts of physiological saline solution.

4. Bile injected into a pancreatic duct of the dog produced such severe injury to the pancreas that the added effect, if any, of dye in the bile could not be properly evaluated.

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REFERENCES

1. Dick, B. M., and Wallace, V. G. H. Cholecystography; toxic effects of dyes; clinical and experimental study. *Brit. J. Surg.*, 1928, *15*, 360-369.
2. Wasch, M. G. New medium for gallbladder visualization. Am. J. Roentgenol. & Rad. Therapy, 1943, *50*, 677–679.
3. Modell, W. Pharmacology of β(3,5 di-iodo-4-hydroxyphenyl)α phenyl propionic acid. *J. Lab. & Clin. Med.*, 1942, *27*, 1376–1384.
4. Junkmann, K. Perorale Cholecystographie mit Biliselectan. *Klin. Wchnschr.*, 1941, *20*, 125–128.
5. Einsel, I. H., and Einsel, T. H. Gall bladder visualization with β(3,5 di-iodo-4-hydroxyphenyl)α phenyl propionic acid (priodax). *Am. J. Digest. Dis.*, 1943, *10*, 206–208.
6. Weber, H. M. New cholecystographic medium. *Am. J. M. Sc.*, 1944, 207, 678–680.
7. Dannenberg, M. Cholecystographic studies with priodax. Am. J. Roentgenol. & Rad. Therapy, 1944, *51*, 328–335.
8. Ochsner, H. C. New cholecystographic preparation. Am. J. Roentgenol. & Rad. Therapy, 1944, *51*, 326–327.
9. Kemp, F. H. Pheniodol; new contrast medium for cholecystography. *Brit. M. J.*, 1943, *2*, 674–676.
10. Hefke, H. W. Cholecystography with priodax; report on 600 examinations. *Radiology*, 1944, *42*, 233–236.
11. Vaughan, W. W., and Eichwald, M. Priodax; contrast medium for cholecystography. *Radiology*, 1944, *43*, 578–581.

12. Marshall, W. A. Some observations on priodax. Am. J. Roentgenol. & Rad. Therapy, 1943, *50*, 680–682.
13. Naumann, W. Die Brauchbarkeit des neuen Gallenblasenkontrastmittels Biliselectan. *Med. Klin.*, 1941, *37*, 968–969.
14. Chiray, M., Lesage, J., and Taschner, E. L'élimination hépatique de la tétraiodophénolphtaléine et ses rapports avec la cholécystographie. *Presse méd.*, 1931, *39*, 1605–1608.
15. Johnson, J., Ellis, A. L., and Riegel, C. Studies of gall bladder function; absorption of sodium tetraiodophenolphthalein from normal and damaged gall bladder. *Am. J. M. Sc.*, 1937, *193*, 483–488.
16. Elman, R. Variations of blood amylase during acute transient disease of pancreas. *Ann. Surg.*, 1937, *105*, 379–384.
17. Opie, E. L. *J.A.M.A.*, 1904, *43*, 1102.
18. Popper, H. L., and Necheles, H. Pathways of enzymes into blood in acute damage of pancreas. *Proc. Soc. Exper. Biol. & Med.*, 1940, *43*, 220–222.
19. Meltzer, S. J., and Salant, W. *J. Exper. Med.*, 1906, *8*, 127.
20. Flexner, S., and Pearce, R. M. *Univ. Pennsylvania Med. Bull.*, 1901, *14*, 193.
21. Archibald, E., and Brow. *Canad. J. Med. & Surg.*, 1913, *33*, 262.
22. Wangensteen, O. H., Leven, N. L., and Manson, M. H. Acute pancreatitis (pancreatic necrosis); experimental and clinical study, with special reference to significance of biliary tract factor. *Arch. Surg.*, 1931, *23*, 47–63.

TWO DANISH PHOTOFLUOROGRAPHIC CAMERAS OF THE ORIGINAL SCHMIDT TYPE*

PAPER III†

By RUSSELL H. MORGAN, M.D., DAVID M. GOULD, M.D., *and* WILLARD W. VanALLEN, B.Sc.

AS EARLY as 1938, the Danish engineer Helm began applying Schmidt optics to photofluorography. After several years of research two cameras, one using 35 mm. perforated film and the other using 70 mm. perforated film, were developed. Within recent months models of both cameras have been brought to the United States by the Tuberculosis Control Division, United States Public Health Service. After minor changes which permitted their adaptation to American photofluorographic equipment, these cameras were subjected to laboratory and field tests to evaluate their characteristics.

Photographs of the two cameras are illustrated in Figures 1, 2 and 3 and schematic diagrams of their essential parts are shown in Figures 4 and 5. In the main, both cameras are of simple Schmidt design and consist essentially of a forward aspherical single-element lens, and a rear spherical mirror. The 35 mm. camera also includes a wide-angle lens approximately 16 inches in front of the aspherical correcting lens. The

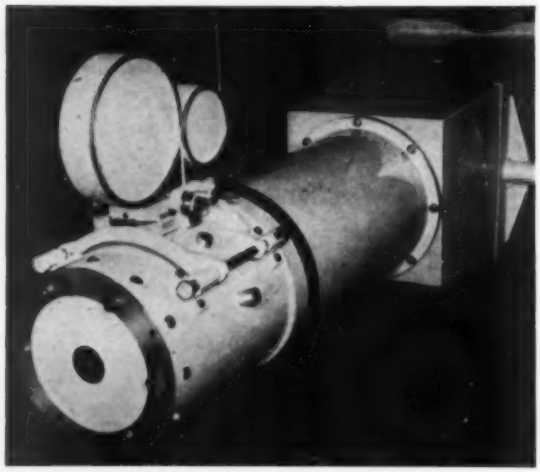

FIG. 1. Closed view of Helm 35 mm. camera.

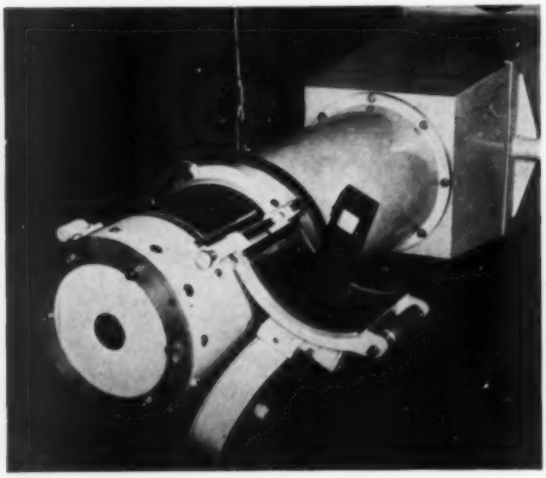

FIG. 2. Open view of Helm 35 mm. camera.

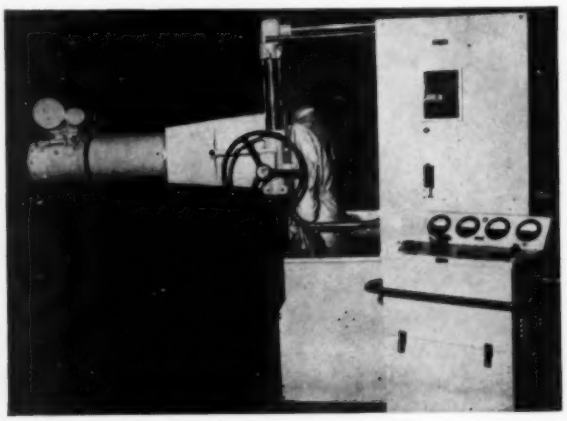

FIG. 3. Helm 35 mm. camera installed on photofluorographic unit.

* From the Department of Radiology, Johns Hopkins Hospital, Baltimore, Maryland; Radiological Section, Tuberculosis Control Division, United States Public Health Service, Bethesda, Maryland.

† For Papers I and II in this series see Am. J. Roentgenol. & Rad. Therapy, January, 1948, *59*, 122–131; February, 1948, *59*, 282–289.

TABLE I

Lens Characteristics	Camera	
	35 mm.	70 mm.
Mirror		
Diameter	9 in.	12 in.
Radius of curvature	9 in.	13 in.
Aperture	$6\frac{1}{8}$ in.	$8\frac{3}{8}$ in.
Focal length*	4 in.	6 in.
f/number (theoretical)*	0.65	0.70
Reduction of aperture by film carrier**	21%	32%
Effective f/number*	0.75	0.85
Resolving power**		
Center	25 lines/mm.	16 lines/mm.
Edge	17 lines/mm.	16 lines/mm.
Corner	12 lines/mm.	16 lines/mm.
Minification**	15.5 diameters	7.4 diameters

* Approximate.
** Measured by National Bureau of Standards.

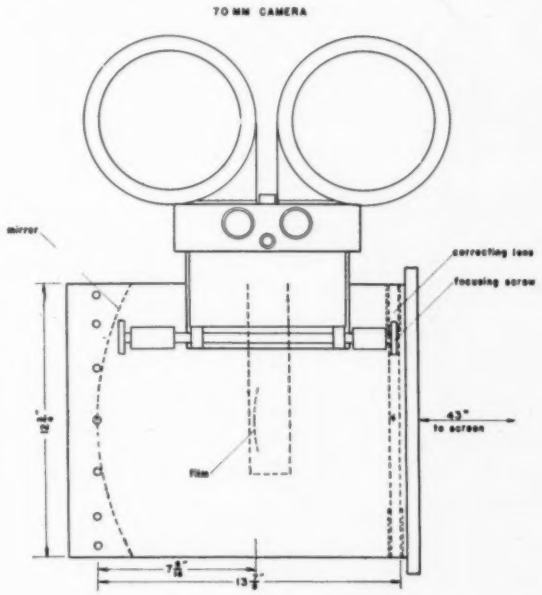

FIG. 5. Schematic diagram of Helm 70 mm. camera.

film carrier mechanism occupies a position between the correcting lens and mirror and is arranged so that the emulsion surface of the film faces the mirror. Furthermore, the film is curved spherically with its center of curvature coinciding with that of the mirror. The cameras are cylindrical in shape and are made of aluminum. In spite of their large size, the cameras therefore are not unusually heavy (50 lb. for the 35 mm. camera and 72 lb. for the 70 mm. camera).

The characteristics of the two lens systems employed in the Helm cameras are

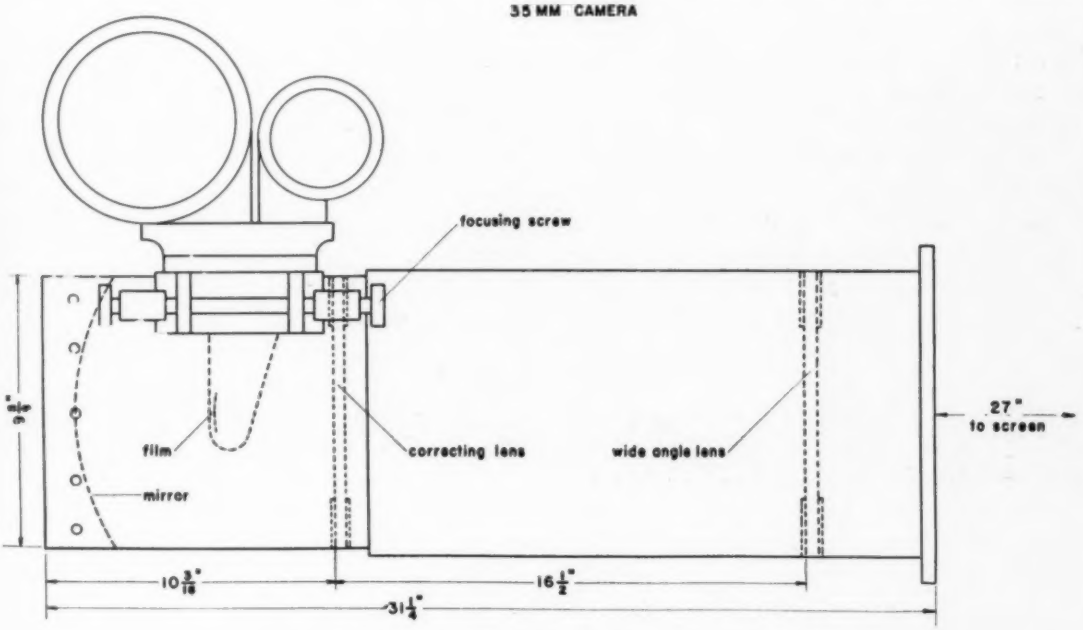

FIG. 4. Schematic diagram of Helm 35 mm. camera.

listed in Table 1. It will be observed that the theoretical f/numbers of the 35 and 70 mm. cameras are respectively 0.65 and 0.70. However, the effective or practical f/numbers are 0.75 and 0.85 respectively since the apertures of the two lenses are encroached upon by the film carriers. It is noteworthy that in spite of this aperture reduction the speeds of the two lenses are unusually high. Indeed, their speeds are many times those of conventional photofluorographic cameras (f/1.5) now in use in the United States.

In general the speed of an optical system is inversely proportional to the square of the f/number. However, this index is not entirely reliable when the object being photographed is a short distance from the lens as in the case of the photofluorographic screen. Accordingly, tests were carried out to determine the comparable amounts of roentgen-ray energy needed to produce a particular blackening of the photofluorographic film within the Helm cameras and within conventional American Recordak and Fairchild cameras. The Recordak camera employing 35 mm. film and the Fairchild camera employing 70 mm. film were equipped with Eastman Ektar f/1.5 lenses. The measurements derived from these tests indicate that the Helm 35 mm. camera is 4.5 times faster than the Recordak camera and the Helm 70 mm. camera is 6 times faster than the Fairchild camera. Both of these values are somewhat higher than that which may be predicted from a consideration of the f/numbers of the four lens systems alone. Part of this difference may be attributed to the simplicity of the optical system of the Schmidt lenses. The amount of glass through which the light must pass before it falls upon the photographic film is extremely small. Second, the number of reflecting surfaces within the lens is considerably smaller than in conventional optical systems. Furthermore, Helm constructed his lenses of uviol glass which has a high transmission, not only within the visible spectrum but also within the ultraviolet region. Thus, if there is any light emitted by the fluorescent screen in the ultraviolet region this light would be effective in producing film blackening in the Helm camera.

One of the interesting features of the Schmidt optical system is its relatively high resolving power or ability to record detail, not only within the center of the field but also at the peripheral portion of the frame. This characteristic is particularly well shown by Helm's 70 mm. camera where the resolving power is uniformly 16 lines per millimeter throughout the entire field.

In the Helm cameras the film magazine and receiver are attached to the film carrier mechanism in the positions shown in the schematic diagrams. Film is fed from the magazine through a light lock, over sprocket wheels and around the film carrier back to the receiver over a second sprocket. Film advance is obtained manually by means of a cord attached to a sliding bar in the 35 mm. camera and a quadrant sector wheel in the 70 mm. camera. During the operation of the film advance mechanism, the pressure plate is first relaxed, and the film then moved forward one frame. Upon release of the film advance lever pressure is again applied to the pressure plate. Since film advance is actuated and metered by sprocket wheels, perforated film is required. The film magazine holds over 500 feet of film. However, after any number of pictures have been taken the film may be cut in daylight and the receiver removed.

The curvature of the pressure plate in the 35 mm. camera is not great enough to cause buckling of conventional 35 mm. film. In the 70 mm. camera, however, ordinary thin-base film does not lie flat against the curved pressure plate and it is necessary to use film with a base not less than 0.008 in. (0.2 mm.) in thickness. Film even heavier than this is recommended. Focusing the cameras is accomplished by means of a micrometer screw and lock screw mechanism which shifts the whole film carriage along the axis of the camera.

The adjustment is extremely critical and must be done with great care to insure a permanent focus. A shift of 0.001 inch is sufficient to throw the image out of focus. The picture size of the 70 mm. Schmidt camera is 55×55 mm., compared to 63 ×68 mm. of the Fairchild camera. The picture area of the 35 mm. Schmidt camera is approximately the same as that of the Recordak camera. The principal advantage of cameras of the Schmidt type is their greater speed. The power requirements for the roentgen-ray generator are thereby lessened, tube life extended, and radiation dosage to the patient reduced. Other roentgen applications in which these cameras may be used include cineroentgenography and photofluorography of such structures as the abdomen, the gastrointestinal tract and the osseous system.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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EDITORIALS

URETHANE THERAPY

URETHANE is an ethylcarbamate ($C_2H_5OCONH_2$) which is frequently used as an anesthetic in laboratory animals since it produces rapid and profound narcosis. Sometimes it is also employed for human anesthesia, especially in children.

Hawkins and Murphy[1] in 1925 noted that animals subjected to urethane anesthesia often showed changes in the lymphoid system which were strikingly similar to those observed following whole body roentgen irradiation. They also found that if rats, under urethane anesthesia, were given roentgen amounts well under the lethal dose, death invariably resulted within seven to fourteen days after the exposure. Later several authors demonstrated that urethane is a powerful growth-inhibiting agent acting by a change or suppression of the mitosis of the cells. Haddow and Sexton,[2] in particular, showed that urethane produces a retardation in the growth of mammary carcinoma in mice and a suppression of Walker rat carcinoma 256. In a more recent publication Murphy and Sturm[3] reported that rats inoculated with leukemic cells and treated with urethane failed to develop the disease whereas in an inoculated but untreated control group only 16.9 per cent of the animals were resistant. A similar inhibiting effect was discovered for lymphosarcoma.

It was this experimental work on the growth-inhibiting effects of urethane that induced several clinical investigators to try to use the drug in man for the treatment of leukemia and some other malignant neoplastic diseases characterized by mitosis.

The first report on the results was presented in 1946 by Paterson, Haddow, ApThomas and Watkinson.[4] These authors treated cases of myeloid and lymphatic leukemia, as well as a few other types of malignant disease. The observations ranged over periods of from five weeks to eleven months. Of 19 cases of myeloid leukemia (18 chronic and 1 acute) 13 received urethane alone and in 6 the urethane was followed by roentgen therapy. All showed a remarkable response, the white cell count often exhibiting a dramatic fall. There was also a rise of the hemoglobin in 10 cases. The grossly enlarged spleen regressed considerably in most instances and in some it became impalpable. The general condition of the patients started to improve immediately and the relatively asymptomatic state continued for a shorter or longer duration. The amount of the urethane given varied a great deal, doses of from 19 to 134 gm. being necessary to produce a fall to about 20,000 white cells over a period of from eleven to thirty-six days. It was found impossible to correlate accurately the dose with body weight or with the rate of diminution of the number of white blood cells. The cases which received subsequent roentgen therapy included some which proved refractory to the urethane, others in which the drug had to be discontinued because of severe nausea, and two terminal cases. Except these latter, all cases showed the usual response to the irradiation.

Of 13 cases of lymphatic leukemia (12

[1] Hawkins, J. A., and Murphy, J. B. The effect of ethyl urethane anesthesia on the acid-base equilibrium and cell contents of the blood. *J. Exper. Med.*, 1925, *42*, 609–618.

[2] Haddow, A., and Sexton, W. A. Influence of carbamic esters (urethanes) on experimental animal tumours. *Nature*, London, 1946, *157*, 500–503.

[3] Murphy, J. B., and Sturm, E. The inhibiting effect of ethyl urethane on the development of lymphatic leukemia in rats. *Cancer Research*, 1947, *7*, 417–420.

[4] Paterson, Edith, Haddow, A., ApThomas, Inez, and Watkinson, Jean M. Leukaemia treated with urethane compared with deep x-ray therapy. *Lancet*, 1946, *1*, 677–682.

chronic and 1 acute), in 9 urethane alone was used and in 4 roentgen therapy was given after a trial of the urethane. On the whole, the response of lymphatic leukemia to urethane was found to be less pronounced and more variable than in myeloid leukemia. The smallest dose given was 8 gm. which reduced a white blood cell count of 48,000 to 7,000 in nine days. At the other extreme, a dose of 300 gm. produced a regression of a white blood cell count of 750,000 to normal after sixty-three days. In the cases which received roentgen therapy following unsuccessful trial of urethane the response was the same as if no urethane were given.

To obtain a direct comparison of the urethane action with that of the roentgen rays, Paterson, Haddow, ApThomas and Watkinson also studied a contrast group consisting of 31 cases of the myeloid type and 14 cases of the lymphatic type of leukemia treated with deep roentgen therapy alone. In the myeloid leukemia the irradiation was applied to the spleen. Two techniques of procedure were used. In one, a dose of 200–500 r was administered weekly over a period of several months, in the other daily doses of 100–200 r were given for shorter periods, not exceeding three weeks. In the lymphatic leukemia the treatment included the spleen as well as the enlarged lymph nodes. The irradiation, here too, was carried out either with doses of 250 r at intervals of a week, or with daily doses of 100–200 r for a period of four to ten days, repeated later when required.

In studying the results, Paterson and her associates arrived at the conclusion that urethane produces effects which are along the same line as those obtained by the usual methods of deep roentgen therapy. As already mentioned, the response was somewhat more pronounced in the myeloid than in the lymphatic type of leukemia. However, although in many cases the palliative effect was quite great, there was no indication from the short period of study that a permanent result may be derived. After a certain interval immature cells reappeared in the blood and in not a few instances a relapse has developed.

As a side reaction the authors noted nausea in about 50 per cent, vomiting in 25 per cent, and diarrhea in about 10 per cent of the cases treated with urethane. In a few instances these symptoms were sufficiently severe to necessitate the withdrawal of the drug.

Paterson, Haddow, ApThomas and Watkinson also studied the effect of urethane in 13 cases of advanced carcinoma of the breast and in 13 cases of other types of malignant disease. Of these, 9 developed a moderate leukopenia. In one the white blood cell count dropped to 1,200 but returned to normal after the urethane was withdrawn. In regard to its action on the tumor proper, in 3 of the breast cases and in 4 of the miscellaneous group there was a transitory regression in the size of the lesions.

Stimulated by these early results, other investigators prescribed urethane and its derivatives for the treatment of leukemia and of various types of malignant neoplasms. Most of the published reports, however, are preliminary. Although the inhibitory effect of the urethane on growth is generally recognized, proof of a long-range clinical value of the method is lacking. Also, there is an accumulating evidence that the drug is not altogether harmless.

Recently, Berman and Axelrod[5] reviewed the entire literature on urethane therapy. They were able to collect only 90 cases of malignant neoplastic diseases which were treated by urethane or some closely related compounds. Brief references to some phase of the effect of the drug were made by a number of other writers but within rather restricted limits. To this collected series the authors add 8 cases of their own in which detailed clinical, hematologic and histologic observations were made. The cases include 4 patients with leukemia, one

[5]Berman, L., and Axelrod, A. R. Effect of urethane on malignant diseases; clinical, hematologic and histologic observations on patients with carcinoma, leukemia and related diseases. *Am. J. Clin. Path.*, 1948, *18*, 104–120.

with lymphatic leukemic reticuloendotheliosis, one with multiple myeloma, one with mycosis fungoides and one with generalized carcinoma.

An analysis of the ultimate results of the cases collected from the literature shows that there are no claims of permanent cures. Some palliation was noted in carcinomatosis, lymphoblastoma and chiefly in leukemia. The androgen-independent carcinoma of the prostate also exhibited promising improvement. The most important changes in the leukemias were diminution in the size of the spleen, liver and enlarged lymph nodes and a reversion toward a more normal peripheral blood picture. In Berman and Axelrod's cases there was little or no clinical improvement in 3 of 4 patients with leukemia although they exhibited some hematologic responsiveness and there was a diminution in the size of the spleen, liver and enlarged lymph nodes. Two patients died of their disease during the treatment. In the 4 patients with other malignant diseases the general status was poor to begin with and it remained so after treatment.

Of great interest are the hematologic observations made by Berman and Axelrod. It was noted that urethane caused a fall in all leukocytic elements whether or not the initial blood count showed a normal or leukemic pattern. The immature elements are affected to a greater extent than the more differentiated forms. Leukopenia, thrombocytopenia and hypoplastic anemia are toxic effects indicating bone marrow injury which may prove of temporary duration or be permanent. The possibility of hepatocellular damage must also be considered.

Two factors stand out in conjunction with these hematologic changes. The one is that the progressive effect of the urethane may continue after the drug has been withdrawn and the other is the lack of correlation between the amount of urethane given and the extent or rate of change in the peripheral blood or bone marrow pattern. For this reason, repeated blood and bone marrow studies are required during the entire course of the treatment not only to help in properly evaluating the efficacy of the urethane action but also to safeguard against possible dangerous overtreatment.

That such danger exists has already been observed by Paterson, Haddow, ApThomas and Watkinson. One of their cases of myeloid leukemia died as a result of aplasia of the hematopoietic system and another, in which a marked drop in the white and red blood cells developed after large amounts of urethane had been given over a long time, later recovered following transfusions. It was felt that in both cases the drug was partly responsible for the deleterious effect.

Webster[6] also noted a fatality in a case of myelogenous leukemia after treatment with urethane. His patient was first treated with roentgen rays. After six months an exacerbation of the disease developed and at this time urethane in daily doses of 3 gm. by mouth, which is now the commonly used dose, was prescribed. There was the usual hematologic response but the drop in the white blood cell count occurred at a somewhat slower rate. After thirty-nine days of medication, or a total dose of 117 gm. of urethane, the patient started to exhibit hemorrhagic phenomena although the blood count showed 24,000 white cells and 80 per cent hemoglobin. The urethane was immediately withdrawn but apparently the blood cell inhibition was already so profound that despite all counter measures fourteen days later the white blood cell count fell to 100 and the patient died with cerebral hemorrhage. On the basis of this observation and after reviewing 3 other cases reported in the literature with deleterious effect due to urethane medication, Webster expresses the opinion that the drug is more toxic in leukemia than previously noted and that therefore its increased use warrants a word of caution.

It is perhaps of more than academic in-

[6] Webster, J. J. Urethane in leukemia. *J.A.M.A.*, 1947, *135*, 901–903.

terest in this respect, especially in considering the life expectancy of the patient, that urethane is a known carcinogenic agent. Nettleship and Henshaw[7] were able to induce pulmonary tumors in mice with urethane in 1943 and since then several similar articles have appeared in the literature. In 1944 Henshaw and Meyer[8] reported on the minimal number of anesthetic treatments which are required with urethane to induce the tumors. Later Jaffé[9] secured pulmonary adenomas in rats both by injection and by feeding. Some of Jaffé's animals also developed tumors in the liver. Recently Guyer and Claus[10] published a report dealing with the induction of lung tumors in rats by means of intraperitoneal injections of urethane. A dose of 1 cc. of a 10 per cent aqueous solution per 100 gm. of body weight was given. Multiple pulmonary adenomatous tumors developed in the majority of 91 rats so treated, including one lot of 28 which had been selectively bred for many years to obtain immunity to carcinoma transplants. The animals became ill eight to ten months after the first injection of urethane and died with rapid weight loss one or two months later. Postmortem examinations revealed numerous tumors beneath the pleura of the lungs with occasional nodules more deeply imbedded in the lung parenchyma but there was no evidence of tumors elsewhere in the body. Three animals received one single injection and they all developed tumors although not as plentifully as rats receiving multiple injections.

From a study of the cytological effects on various tissues, Guyer and Claus determined that urethane acts by reducing all stages of mitosis for some twelve to sixteen hours. This apparently accounts for the retardation of growth in the malignant neoplasms with the concomitant drop in the white blood cells, especially in the leukemias. Whether the temporary mitotic suppression also plays a role in the initiation of pulmonary tumor formation or is merely an accompanying response to the causative agent remains a problem for further investigation.

All in all, the evidence available at the present time points to the fact that urethane therapy is of limited value. In the leukemias it leads to palliation of shorter or longer duration, but in view of the marked cytotoxic effect a very careful control by repeated hematologic and bone marrow studies is necessary during the entire course of the treatment. In the various types of malignant neoplasms in which it has been tried its merit was found to be rather doubtful. It is perhaps not too speculative to say that the method will not replace radiation therapy or other established procedures in the treatment of either of these conditions. If used in cases with an expected longer survival, the possible carcinogenic effect, especially on the lungs, must also be taken into consideration.

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T. Leucutia, M.D.

[7] Nettleship, A., and Henshaw, P. S. Induction of pulmonary tumors in mice with ethyl carbamate (urethane). *J. Nat. Cancer Inst.*, 1943, *4*, 309–319.

[8] Henshaw, P. S., and Meyer, H. L. Minimal number of anesthetic treatments with urethane required to induce pulmonary tumors. *J. Nat. Cancer Inst.*, 1944, *4*, 523–525.

[9] Jaffé, W. G. Carcinogenic action of ethyl urethane on rats. *Cancer Research*, 1947, *7*, 107–112.

[10] Guyer, M. F., and Claus, P. E. Tumor of the lung in rats following injections of urethane (ethyl carbamate). *Cancer Research*, 1947, *7*, 342–345.

ALBAN KÖHLER
1874—1947

ALBAN KÖHLER, whose death occurred February 26, 1947, was born in Petsa, not far from Altenberg in Thüringen, March 1, 1874. All of his ancestors were farmers, as official records show, as far back as the year 1440. He was given a classical education, in the course of which he showed exceptional talent in languages, including Italian, Polish, Russian, English and French. He studied medicine at the University of Freiburg and also studied in Erlangen and in Berlin.

At first inclined toward surgery, he was made assistant to Freidrich Kramer in

Wiesbaden in 1899. However, his surgical activities were early associated with medical radiology, to which he immediately gave his major interest. One of his earlier publications appeared in 1901 when he was twenty-seven years of age, "Roentgen Aspects of Osseous Diseases." In 1902 he settled in Wiesbaden, establishing his roentgen-ray equipment and his consulting offices in his home, an arrangement he continued all his life. In 1903 he decided to limit his practice to roentgenology, thus becoming one of the earliest physicians to so dedicate himself. His industry and keen interest in radiology early showed results in two more books: "Hip Joint and Femur in the Roentgen Picture" and "Roentgen Diagnosis of Tuberculous Adenitis in Children."

The German Röntgen Society, which was organized in 1905, recorded Alban Köhler as one of its founders and in 1912 its president. He was later elected to honorary membership and awarded the Society's gold medal.

The chief accomplishment of Alban Köhler, however, was the publication in 1910 of his book entitled "The Limits of the Normal and the Beginnings of the Pathological in Roentgenology," a book which has gone through eight editions and whose ninth edition was in process of publication until interrupted by aerial bombardment and fire during the war. In each of these new editions Köhler worked indefatigably to keep it revised thoroughly up-to-date. Perhaps more than any other single thing, this book of Köhler's which has been translated into many languages, has contributed potently to the widespread fame of German science.

Thirteen foreign medical and roentgen societies elected him as an honorary or corresponding member, largely on the basis of this book which has appropriately been called the "Radiologist's Bible." He was also an honorary fellow of the American College of Radiology; corresponding member of the American Roentgen Ray Society, and a life member of the British Institute of Radiology.

Dr. Köhler never had any teaching connection with universities. He practiced as a radiological specialist in Wiesbaden, rejecting invitations to various high administrative positions in big clinics or hospitals. These prospects never allured him. He did nearly everything by himself; later on he had an occasional volunteer assistant and then a laboratory technician. His faithful wife helped him in his office until her death in 1942. The simplest roentgenological operation he accomplished often more easily than did many other roentgenologists with more modern devices, which were more costly than could be afforded by a private practice.

He was lucky enough to escape any severe roentgen-ray damage, although he himself exposed and developed nearly all of his plates and films for forty years. He used fluoroscopy very little, especially in the earlier years, and thereby was lucky enough to be spared any roentgen-ray damage.

His last days were unhappy. His wife was taken from him in 1942 and in 1945 his only son fell on the Western Front. Just before that, Wiesbaden was bombed in a very severe air attack, and in connection with this bombardment he had the misfortune to lose by fire not only his home but also his large roentgen institute which was incorporated with it. His loss also included his historical library, one of the outstanding radiological libraries of the world. He also lost the notes and illustrations of the ninth edition of his well known book, although the first 250 pages had already been printed before the publisher's plant in Leipzig was bombed out.

Toward the last he renewed contacts with many of his friends in the United States and was grateful to them for their generous response to his call.

Köhler pioneered in many roentgen activities. His earlier publications have already been mentioned, but in addition he

pioneered in teleroentgenography, the localization of foreign bodies in the eye, stereoroentgenography of the chest; cinematography of the respiratory tract (1907); the observation of calcific plaques in the aortic arch, and numerous other phases of roentgen diagnosis. His name has been given to two diseases: osteochondritis os navicularis pedis and osteochondritis of the second metatarsophalangeal joint. He was one of the early users of filters in roentgen therapy. There is no doubt that his influence will long continue among radiologists in all lands.

James T. Case, M.D.

WESTON A. PRICE, D.D.S.
1870—1948

WESTON A. PRICE, D.D.S., formerly of Cleveland, Ohio, died January 23, 1948, at Santa Monica, California, where he had lived since retiring from active practice in 1943. Dr. Price had been a charter member of the American Roentgen Ray Society and secretary of the Society in 1901. Born in 1870, in Newburgh, Ontario, he studied at the Collegiate Institute, Naponee, Ontario, and received the degree of Doctor of Dental Surgery from the University of Michigan in 1893. Thereafter he practiced his profession in Cleveland for fifty years.

Dr. Price was an eminent scientist. He probably was the first, in this country at

least, to employ dental roentgenography in practice. He published many articles on the subject, the first appearing in Transactions of the American Roentgen Ray Society in 1904, entitled "Technique Necessary for making Good Dental Skiagraphs." Other early articles dealt with dental infections in relation to diseases, cataphoresis, and desensitization of teeth, and the first pyrometer furnace which he invented for baking porcelain. The principal interest to which he devoted his active life was investigation of the influences of nutrition, especially calcium metabolism, on the development of the teeth. He traveled to remote parts of the earth to study the influence of dietary habits on the dental characteristics of primitive peoples. These investigations resulted in a valuable collection of photographs of these dental characteristics, which he presented to the American Academy of Applied Nutrition.

Dr. Price had been president of the Cleveland Dental Society, Ohio State Dental Society, Northern Ohio Dental Association, a Fellow of the American Association for the Advancement of Science, a member of the American Dental Association, American Association of Applied Science, the American Association of Physical Anthropologists, the Biological Society of Great Britain, and the International Association for Dental Research.

The accomplishments in original researches and participation in scientific societies in which he was active reveal the inherent attributes of Dr. Price. In addition he was well loved by his patients and respected in the community. It is not trite but a truism to state that he was a "scholar and a gentleman." The American Roentgen Ray Society is proud that he was a member.

U. V. Portmann, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14–17, 1948.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Stevens Hotel, Chicago, Ill., June 20–22, 1948.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1948, to be announced.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Continental Hotel, Chicago, Ill., June 20, 1948.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Chicago, Ill., June 21–25, 1948.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive,

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year. January, May, November.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meetings fourth Monday of each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio. Next meeting at annual meeting of Ohio State Medical Association, Cincinnati, Ohio, March 31, 1948.

Oklahoma State Radiological Society
Secretary, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual meeting, May 21–22, 1948, Erie, Pa., at Hotel Lawrence.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bimonthly on second Thursday, at place selected by Secretary.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah Radiological Conference
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

Utah State Radiological Society
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting May 13 and 14, 1948.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland. Annual meeting, on the Bürgenstock, near Lucerne, May 22 and 23, 1948.

AMERICAN RADIUM SOCIETY

A program of unusual interest is promised for the annual meeting of the American Radium Society for June 20, 21 and 22, 1948, Hotel Stevens, Chicago, Illinois. The Program Committee has invited a number of foreign guests who will report on recent advances in European radiotherapy, which information was inaccessible to Americans during the war years. The following have already promised to present reports on Radium and Roentgen Treatment of Cancer: Francois Baclesse and Juliette Baud of the Curie Foundation, Paris, the former in charge of roentgen therapy, the latter of radium therapy; Elis Berven, Professor of Radiotherapy at the University of Stockholm and Director of Radiumhemmet; Sir Stanford Cade of London, who has written a most informative book on Radium and Cancer; Brian Windeyer, Professor of Radiotherapy at the University of London, and Director of the Meyerstein Institute of Radiotherapy of the Middlesex Hosptial, London; Constance Wood, Director of the Radiotherapeutic Research Unit of the British Medical Research Council, in charge of Radium Beam; Dr. R. McWhirter, Director of Radiology, Royal Infirmary, Edinburgh, Scotland, who has treated twenty-five hundred patients with cancer of the breast with local mastectomy and postoperative roentgen treatment.

A number of equally eminent American Radiotherapists will also participate. An oration on the Discovery of Radium will be given by Dr. Edith H. Quimby at the banquet. The Janeway Lecture, Monday afternoon, on the "Achievement of Radium in the Fight against Cancer," will be given by Sir Stanford Cade. Panel discussions on the treatment of cancer of the tongue, cancer of the breast and "Should Radiotherapy be Separated from Roentgen Diagnosis" and separate papers will be given Monday and Tuesday. Special Refresher Courses will be given by the foreign guests Sunday morning preceding the regular sessions.

Those interested will find it advantageous to write to Stevens Hotel, Chicago, Illinois, for reservations immediately and to Dr. Maurice Lenz, Chairman, Program Committee, 840 Park Avenue, New York 21, New York, for further information regarding the Refresher Courses.

MID-WEST RADIOLOGIC CONFERENCE

The eighth annual Mid-West Radiologic Conference was held in Milwaukee, Wisconsin, at the Hotel Schroeder on February 6 and 7, 1948. The meeting was sponsored by the Milwaukee Roentgen Ray Society. The attendance was excellent and many interesting subjects were discussed by the speakers.

On Friday, February 6, the following papers were given. Except where noted otherwise the speakers were from Milwaukee.

Address of Welcome. J. C. Griffith, M.D., President, Medical Society of Milwaukee County.

The Collapse Therapy of Pulmonary Tuberculosis from a Roentgenological Standpoint. John D. Steele, M.D.

Diagnostic and Therapeutic Aspect of Tumors of the Hypophyseal Region. Joseph Mufson, M.D.

The Effect of Splenic Irradiation on the Vascular Lesions in Purpura. Frederick W. Madison, M.D.

The Treatment of Leukemia and Other Blood Disorders with Urethane. John S. Hirschboeck, M.D.

Congenital Cardiac Lesions simulating Tetralogy of Fallot. Francis F. Rosenbaum, M.D.

The Importance of Cholangiograms in Common Duct Surgery. Carl W. Eberbach, M.D.

Cardiac Roentgenology in Patients over Forty. J. Edwin Habbe, M.D.

Etiology and Pathogenesis of Prolapsed Gastric Mucosa into the Duodenum. A. Melamed, M.D.

Intussusception in Children. Arthur Schaefer, M.D., and John L. Armbruster, M.D.

Diagnosis of Malignancies by Smear Technique. Leander J. Van Hecke, M.D.

The Excretory Urogram as a Test of Renal Function. James C. Sargent, M.D.

Diagnosis of Small Esophageal Hiatus Hernias. S. Archibald Morton, M.D.

The Production of High Energy Electron Beams and Their Possible Use in Medical Therapy. Jack T. Wilson, Ph.D.

Diagnostic and Therapeutic Aspects of Tumors of the Testicle. S. B. Pessin, M.D., and Irving I. Cowan, M.D.

Diagnostic Problems of the Esophagus. Gerhard D. Strauss, M.D.

Radiation Therapy Problem Clinic. Irving I. Cowan, M.D., R. R. Newell, M.D., San Francisco, California, and Ernst A. Pohle, M.D., Madison, Wisconsin.

On Friday evening a banquet was held at which the guest speaker was Dr. R. R. Newell, Professor of Radiology, Stanford University School of Medicine, San Francisco, California. His subject was "Doctors' Duties and Opportunities in the New Age of Atomic Energy."

On Saturday morning, February 7, there was a Symposium and Round Table Discussion of "Fractures in Children." This was participated in by the following:

Fractures of the Humerus and Forearm in Children. Walter P. Blount, M.D.

Fractures of the Lower Extremity in Children. Albert C. Schmidt, M.D.

Fractures of the Elbow in Children. Irwin Schulz, M.D.

The meeting closed with a Film Study Session with S. A. Morton, M.D., Moderator, Hans Hefke, M.D., Theodore Pfeffer, M.D., and L. W. Paul, M.D., Madison, Wisconsin.

AMERICAN BOARD OF RADIOLOGY

Heretofore the American Board of Radiology has demanded that all candidates admitted to examination should be graduates of an approved Class A medical school. The Board has recently ruled, however, that those who have graduated from foreign and sub-standard medical schools before 1947 may be admitted to the examination if and when they have complied with the other requirements of the Board. No candidate who graduates from a substandard school (foreign or domestic) after 1947 will be admitted to the examination.

The Board has also ruled that a maximum credit of six months toward the required three years' training may be allowed for formal didactic courses in the basic sciences.

Many candidates who have applied for the entire field of Radiology or Roentgenology and who pass the examination in Diagnostic Roentgenology or possibly the Therapy part of the examination, ask for a limited certificate in the field in which they have passed, expecting to re-apply shortly for the other field. This they are entitled to do but in order to discourage candidates taking partial certificates the Board has ruled that two years must elapse after a candidate accepts a certificate in one field before he may apply for additional certification.

B. R. Kirklin, M.D.
Secretary-Treasurer
American Board of Radiology

Vol. 59. No. 3

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

SPECIAL PROJECTIONS FOR THE CORACOID PROCESS AND CLAVICLE

By KAETHE FENGLER
Chief Technician, Department of Radiology, The Mount Sinai Hospital
NEW YORK, NEW YORK

THE purpose of presenting the following three cases is to emphasize the importance of employing special projections for the coracoid process of the scapula (Cases I and II) and for the clavicale (Case III). Each of these special positions is equally effective in avoiding overlapping of the coracoid process and demonstrating the clavicle free of rib shadows. In the standard positions the existing lesions in the cases presented here are either barely visible or are inadequately demonstrated.

CORACOID PROCESS

Special projections for the coracoid process were described in several textbooks early in the century but in only a few of the more recent ones.[1,2,4,5] The degree of central ray angulation recommended varies considerably. It is felt, however, that the angulation required for an adequate dem-

Fig. 1. Conventional roentgenogram of affected shoulder

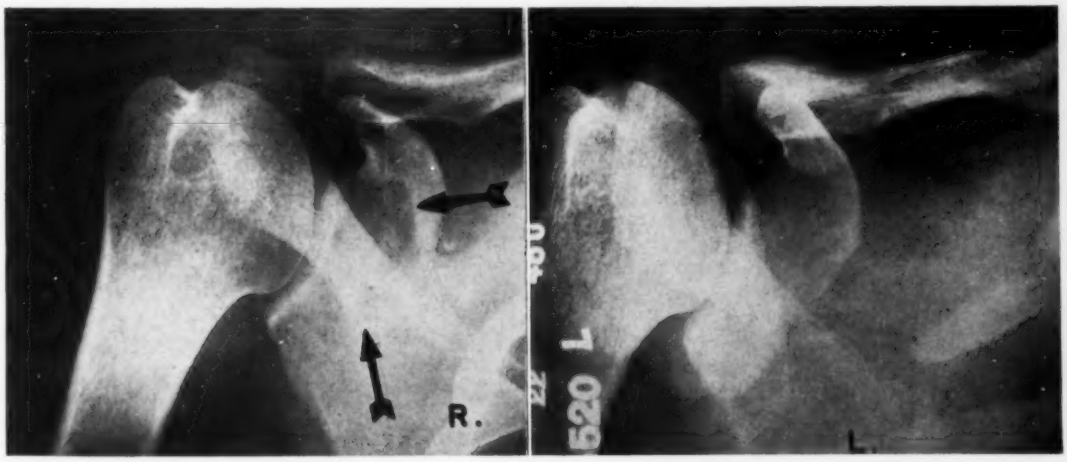

Fig. 2. Special projection for the coracoid process. Right shoulder metastatic lesion. Left shoulder normal for comparison.

Fig. 3. Tuberculosis of coracoid process. Conventional anteroposterior view on the right shows destructive lesion hidden by adjacent bones. Special coracoid view on the left shows lesion free of superimposed shadows.

onstration in each individual case depends entirely upon the degree of dorsal kyphosis. The sway-backed subject due to the fact that his shoulder will be flat on the table will require an average central ray angulation of from 15°–20° toward the head. The round-shouldered subject will require an average angulation of from 30°–35°.

Fig. 4. Special coracoid view of normal shoulder for comparison.

PROCEDURE

Posture
Patient supine.
Center affected coracoid process to midline of the Bucky.
Elevate the opposite shoulder enough to place scapula parallel with plane of film. Abduct the arm slightly, supinate and immobilize the hand.

Central ray
Direct central ray to affected coracoid process at an average angle of from 20°–30° toward the head.

Film position
Adjust position of cassette so that the midpoint of film coincides with the central ray.

Respiration
Suspend respiration at end of exhalation.

Case 1. N. L.

Request
Right shoulder.

Clinical diagnosis
Subdeltoid bursitis.

Positions
(a) Anteroposterior conventional.
(b) Special projection—anteroposterior, 25° central ray angulation toward head.

Technique
65 kv., 50 ma-sec., 36 inch distance. Bucky diaphragm.

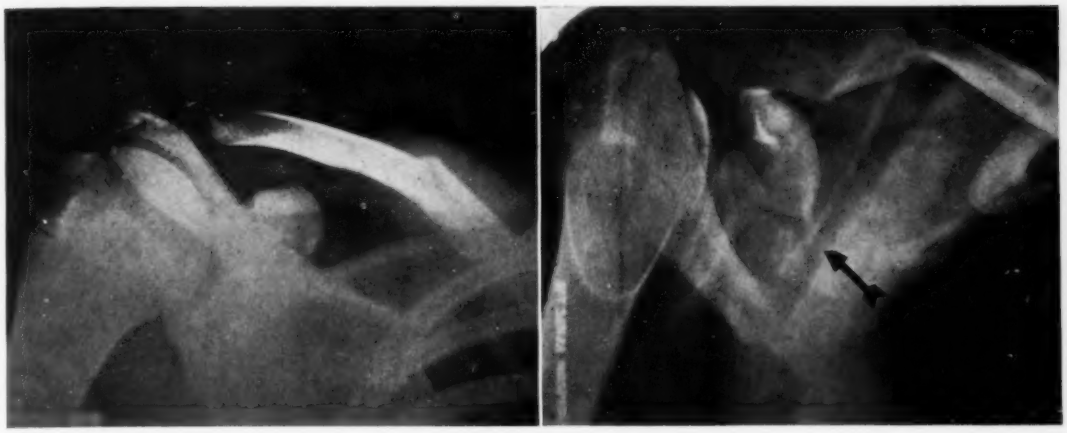

Fig. 5. Conventional view of the shoulder on the left, showing fractured clavicle. The base of the coracoid is obscured by the superimposed acromion. On the right, special posteroanterior view of clavicle also reveals clearly fracture of coracoid.

Roentgenological findings
Large area of rarefaction with poorly defined borders situated in the upper portion of the glenoid process and neck of the scapula extending into the base of the coracoid process.
Roentgenological diagnosis
Metastatic neoplastic process.
Pathology
Curettage of neck of right scapula.
Pathological report No 88723—Malignant tumor, probably metastatic.

Case II. S. P.

Request
Left shoulder.
Clinical diagnosis
Tuberculous bursitis.
Positions
(a) Anteroposterior conventional.
(b) Special projection—anteroposterior, 30° central ray angulation toward head.
Technique
70 kv., 50 ma-sec., 36 inch distance. Bucky diaphragm.
Roentgenological findings
Destructive lesion involving the tip of the left coracoid process.
Roentgenological diagnosis
Tuberculous osteitis.
Aspiration biopsy
Tuberculosis.

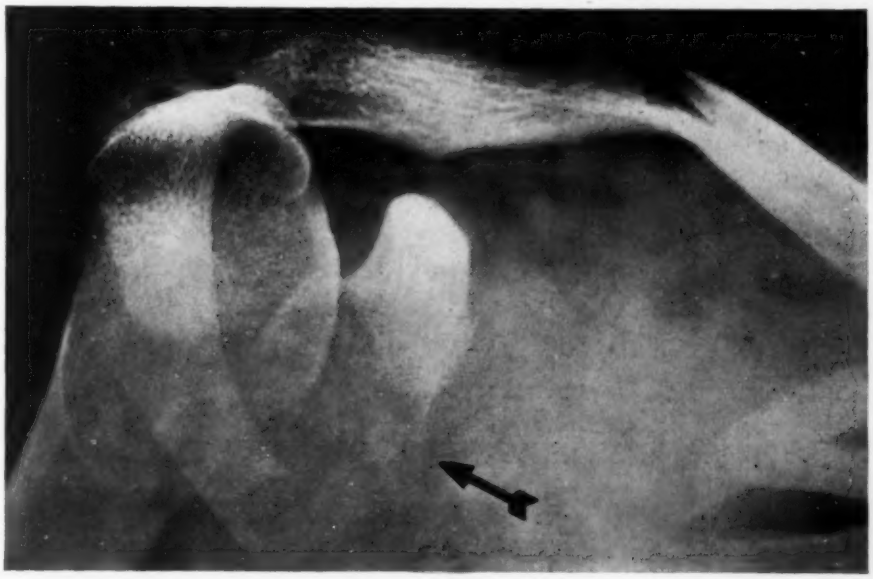

Fig. 6. Special posteroanterior view of clavicle which also shows fractures of clavicle and coracoid (process) clearly.

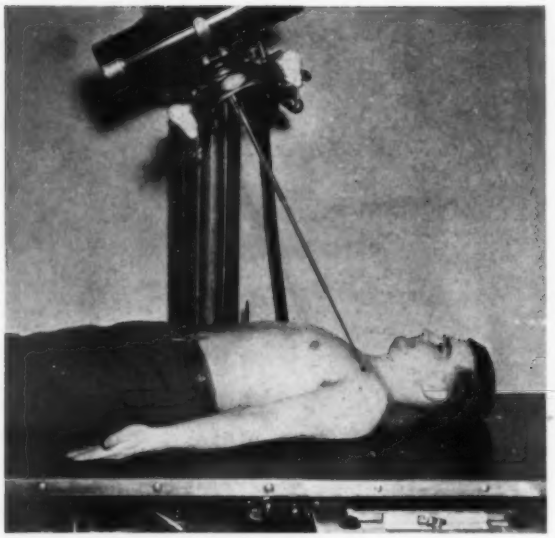

FIG. 7. Photographic demonstration of the special anteroposterior projection for the coracoid process.

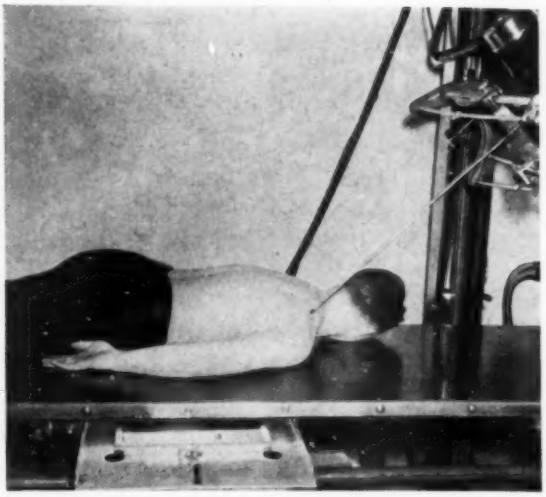

FIG. 8. Photographic demonstration of the special posteroanterior projection for clavicle and coracoid process.

CLAVICLE

The most commonly used projections for the clavicle are the posteroanterior view and the anteroposterior infrasuperior view. However, it is felt that a special projection, one of the two recommended by Quesada,[3] is advisable. The patient remains in the posteroanterior position throughout the examination.

PROCEDURE

Posture

Posteroanterior, preferably erect for the patient's comfort, or recumbent. Center the clavicle to the midline of the Bucky, arms alongside of body. Turn the face away from the affected side to prevent superimposition on the clavicle.

Central ray

Direct central ray to mid-point of clavicle at an angle of 45° toward feet.

Film position

Adjust cassette so that mid-point of film will coincide with central ray.

Respiration

Suspend respiration at the end of exhalation.

Technique

70 kv., 50 ma-sec., 36 inch distance. Bucky diaphragm.

CASE III.

Request

Left shoulder.

Clinical diagnosis

(a) Fracture of clavicle and
(b) humerus.

Positions

(1) Posteroanterior conventional.
(2) Special projection—posteroanterior, 45° central ray angulation toward feet.

Technique

70 kv., 50 ma-sec., 36 inch distance. Bucky diaphragm.

Roentgenological findings

(1) Fracture of clavicle.
(2) Fracture of coracoid process.

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REFERENCES

1. Military Roentgenology. War Department Technical Manual. T. M. 8–280. Supt. of Doc., Govern. Print. Off., Washington, D. C., 1944.
2. Outline of Modern X-Ray Technique. Third edition. Picker X-Ray Corporation, New York, 1941.
3. QUESADA, F. Technique for roentgen diagnosis of fractures of clavicle. *Surg., Gynec. & Obst.*, 1926, *42*, 424–428.
4. RHINEHART, D. A. Roentgenographic Technique. Third edition. Lea & Febiger, Philadelphia, 1943.
5. SANTE, L. R. Manual of Roentgenological Technique. Tenth edition. Edwards Bros., Inc., Ann Arbor, Michigan, 1943. (Eleventh edition 1944, p. 85).

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Lysholm, Erik. Experiences in ventriculography of tumours below the tentorium. *Brit. J. Radiol.*, Nov., 1946, *19*, 437–452.

This paper was read as the Mackenzie Davidson Memorial Lecture before the British Institute of Radiology. The author discusses the 467 subtentorial lesions which were seen during a period of fifteen years and which were investigated by ventriculography. The lesions encountered included aqueduct stenosis, arachnoiditis, and tumors of the corpora quadrigemina, pons, cerebellopontine angle, suprafastigial and infrafastigial portions of the vermis, and cerebellar hemispheres. Most of the diagnoses were verified and in many of the cases presented, the ventriculographic and gross pathological findings are depicted together.

Localization of tumors of the quadrigeminal plate was accurate in slightly more than half of the cases. Of 58 vermis tumors there was accurate localization possible in 49. In cerebellar hemisphere tumors it was possible to locate the lesion exactly in 71 of 75 cases.

The paper consists mainly of illustrations with line drawings for explanation. The various lesions are all well shown, and an explanatory note concerning the ventriculographic and pathologic findings is given with each. Since the important part of the article is its illustrations, it should be seen.—*E. F. Lang.*

NECK AND CHEST

Peirce, Carleton B., Crutchlow, Everett F., Henderson, Arthur T., and McKay, Joseph W. Transient focal pulmonary edema. *Am. Rev. Tuberc.*, July, 1945, *52*, 1–14.

The authors make a complete review of the literature on Löffler's syndrome and report 8 cases. It is concluded that the evanescent and variable areas of increased pulmonary density are focal zones of transient pulmonary edema probably associated with the allergic state; they are a local manifestation of the individual's response to an allergen elsewhere, not an inflammatory nodule nor a more general reaction.

In the authors' cases the eosinophilia and roentgenographic pulmonary involvement were out of all proportion to the clinical evidence of the disease.

A note of warning is sounded that care be exercised to ensure that no such cases be stigmatized with the diagnosis of tuberculosis or tuberculosis suspect on one roentgenographic observation. Careful clinical history and physical examination are still required for diagnosis. —*James J. McCort.*

Grossmann, Maria E. Pulmonary oil embolism. *Brit. J. Radiol.*, May, 1946, *19*, 178–180.

Pulmonary embolism is fortunately a rare complication, following uterosalpingography. Several cases of oil embolism have been reported prior to this paper. Fatal cases have also been reported following the injection of oil into the urinary bladder and urethra. An interesting case of pulmonary and cerebral embolism has been described by Hemmeler (1939). He demonstrated fine oil droplets in the lungs two days after the injection.

The author describes 2 more cases of massive pulmonary embolism following investigation for sterility. Chest films in both cases demonstrated tiny sharply defined dense opacities, scattered over both lung fields with a fine reticular distribution. Dense linear and V-shaped opacities were attributed to opaque oil embolism of the pulmonary arteries, arterioles, and capillaries. The roentgen appearance in both cases is comparable to Walther's experimental findings produced by injecting 1 cc. of 40 per cent lipiodol into the ear vein of a rabbit.—*K. K. Latteier.*

Loewenstein, Ernst. Congenital tuberculosis; its clinical importance. *Am. Rev. Tuberc.*, March, 1945, *51*, 225–230.

1. Congenital infection occurs from the placenta and therefore not earlier than the 4th month of pregnancy. Germinal infection plays no role. Infection by aspiration or ingestion of amniotic fluid is rare.

2. Placental tuberculosis is far more frequent

than is generally known, even in cases with very small lesions in the lungs.

3. Congenital foci, especially in the liver may heal spontaneously.

4. Blood from the umbilical cord contained tubercle bacilli in 3 babies whose mothers had rheumatic endocarditis; all 3 babies stayed well. Bacilli were found in the blood from the umbilical cord of 9 cases out of 59 tuberculous mothers; 1 baby died of miliary tuberculosis. Positive umbilical cord blood was found in 2 out of 210 apparently healthy mothers; the 2 babies remained well.

5. Therefore, the prognosis of congenital tuberculosis is not absolutely hopeless, especially when the blood invasion occurs only during delivery.—*James J. McCort.*

Reisner, David, and Downes, Jean. Minimal tuberculous lesions of the lung. *Am. Rev. Tuberc.*, May, 1945, *51*, 393–412.

This is a study of the clinical significance of the tuberculous lesion of the lung of minimal extent. It is based on a study of 469 cases, the majority of which were observed for a period of five years or longer. The classification "minimal tuberculosis" includes lesions of diverse types, ranging from those of an apparently recent origin through those showing various gradations of healing, to lesions of an obviously old and obsolete type. The majority of the patients showing involvement of minimal extent are asymptomatic and aside from the roentgenological findings present few objective criteria for evaluation of their clinical significance.

The character of the lesion at the time of initial diagnosis was found to be closely related to the behavior of the lesion and risk of progressive disease. Lesions of the exudative or exudative-productive type are characterized by an unstable behavior and a distinct tending to progression. Progression was observed in about one-half of the white patients and in 61 per cent of the non-whites. On the other hand, lesions classified as of productive-fibrotic or fibrocalcific character have shown a stationary behavior in the majority of instances, progression or instability having occurred in only 5 per cent of the white and in 14 per cent of the non-white patients. Lesions of the fibrocalcific type showed the highest rate of stability, progression being a rather exceptional occurrence in this type of involvement.—*James J. McCort.*

Long, Esmond R., Tuberculosis as a military problem. *Am. Rev. Tuberc.*, June, 1945, *51*, 489–504.

Exclusion of tuberculosis from military service under current conditions is dependent on rapid, mass roentgen-ray methods. Cases developing in the United States Army in World War II for the most part represent extension from small areas of infiltrative tuberculosis not previously detected. Extension from scarred and calcified primary lesions has not been demonstrated. The author who served as consultant for tuberculosis to the Surgeon General states that the total admission and discharge rates in our Army in World War II are approximately one-tenth of those prevailing in World War I.

The predominant type of tuberculosis occurring in our army was the chronic ulcerative, pulmonary form. Acute forms were relatively rare, at least in the white race and indications were not evident that climate or any specific environment is a factor in the development of fulminating disease.—*James J. McCort.*

Christie, A., and Peterson, J. C. Histoplasmin sensitivity. *J. Pediat.*, Oct., 1946, *29*, 417–432.

The authors have shown in previous studies that there was a definite correlation between histoplasmin sensitivity and lung calcifications. They also, together with other investigators, have found a marked geographical variation in the prevalence of pulmonary calcifications and histoplasmin sensitivity. The present study which elaborates on the previous ones is based on three groups: (1) 181 children from an institute for the care of children in Middle Tennessee aged from 2–19 years and 315 children from a Tennessee industrial school drawing from the whole state of Tennessee and ranging in age from 6–19 years; (2) 1,255 students from Vanderbilt University approximately 50 per cent of whom were natives of Tennessee, and (3) 381 patients from Vanderbilt University Hospital, mostly residents from Middle Tennessee. Both the highest and lowest economic groups were represented.

Of the three groups a total of 1,107 cases had chest roentgenograms and tuberculin and histoplasmin skin tests. Sixty-two per cent of the Tennessee residents who were sensitive to histoplasmin and not to tuberculin had pulmonary calcifications and only 42 per cent who were

tuberculin sensitive and histoplasmin negative showed similar calcifications.

For non-residents of Tennessee the figures were 51.4 per cent pulmonary calcifications among the histoplasmin sensitive tuberculin non-sensitive group and 40 per cent for the tuberculin sensitive histoplasmin non-sensitive group.

Among 610 residents of Tennessee who showed pulmonary calcifications 87.4 per cent were histoplasmin sensitive and only 18.8 per cent tuberculin sensitive. The histoplasmin sensitivity was found to increase rapidly with increasing age from 1.9 per cent in the first year of life to 90 per cent in the 21–22 year group.

The development of tuberculin sensitivity showed a marked difference in the different economic strata. In the group from the lower economic stratum tuberculin sensitivity rose from 6.1 per cent in the 1–2 year age group to 42.8 per cent in the 17–18 year age group. In the higher economic stratum group the University group, the tuberculin sensitivity for the 17–18 year group was only 12.6 per cent.

No cases of pulmonary calcification were seen below five years of age but the incidence rose rapidly to 57.7 per cent in the 9–10 year group and then gradually to 66.7 per cent in the 19–20 year group.

In the graphic plotting of the above statistics a very close and definite correlation becomes apparent between histoplasmin sensitivity and pulmonary calcifications. The same correlation does not seem to exist with tuberculin sensitivity. When the statistical groups are broken down on a geographical basis the correlation between histoplasmin sensitivity and pulmonary calcification is very close. In general, it was noted that the percentage of histoplasmin reactors was higher in the states of the western Appalachian slope and those just west of the Mississippi River.

As to the significance of histoplasmin sensitivity 5 per cent of children in the 4–5 year age group are histoplasmin sensitive and were without any clinically significant infection. It has no value as an exclusion test since most cases with proved advanced histoplasmosis were histoplasmin-negative. The test is probably satisfactory, according to the author, as an exclusion test in mild acute, subacute and chronic cases. This would be comparable to the energy seen in tuberculin testing during miliary infections. It also seems likely that histoplasmosis gives many nonspecific reactions and may serve only as an index of sensitivity to a group of fungi.—*Rolfe M. Harvey.*

Waring, J. I., and Gregg, D. B. Pulmonary calcifications and sensitivity to histoplasmin in Charleston, S. C. *Am. J. Dis. Child.*, Feb., 1947, *73*, 139–142.

In a study of children of school age in Charleston County, S. C., contact tests with tuberculin and roentgenograms on 14 by 17 inch paper films were made on 494 children. Intradermal tests with histoplasmin could not be arranged for all the children. However, 8 with pulmonary calcification and negative reactions to tuberculin were re-examined and each was given an intradermal injection of 1:100 dilution of histoplasmin, and simultaneously an intradermal test with 0.1 mg. of old tuberculin was done. Five of the 8 reacted positively to histoplasmin. All of the 5 had either lived in or made prolonged visits in Kentucky, Tennessee, Alabama or Mississippi within the area of high incidence or sensitivity as determined in the study of the United States Public Health Service. The incidence of sensitivity to histoplasmin in school children was less than 2 per cent. The appearance of calcified pulmonary lesions in children associated with sensitivity to histoplasmin, was less than 1 per cent and it appeared to be an imported problem.

Three patients who were sensitive to histoplasmin showed roentgenographically multiple discrete calcifications more or less concentrated in the inner third of the pulmonary lung fields of both lungs, with bilateral hilar glandular calcifications. One of these patients reacted to both intradermal tests. Lesions of healed primary tuberculosis usually tend to be single nodules in the pulmonary fields with only one lymphatic course to the hilar nodes with few nodes calcified. These are generally more completely calcified and larger than those seen in histoplasmosis. However, in 2 patients who reacted positively to histoplasmin, rather large calcified solitary nodules were found, one of which appeared to be only partially calcified, emphasizing the impression that no reliable distinction can be made by roentgenographic appearance only. One patient who reacted negatively to both tests showed definite solitary

calcified nodules in each pulmonary field and in the left hilar nodes.—*R. S. Bromer.*

Camiel, Mortimer R. Roentgenology of the massive conglomerate lessions of silicosis. *Am. Rev. Tuberc.*, June, 1945, *51*, 527–531.

The author gives the following diagnostic criteria. Two cases are discussed.

1. Subapical or subclavicular location of the lesions is most common; the process is often located in the apices of the lower lobes.

2. The lesions are almost invariably bilateral.

3. There is a tendency toward symmetry.

4. There is frequently a clear zone of emphysema surrounding the lesions and separating them from both the hila and the chest wall. The separation from the hila is an important sign, since it excludes at once lesions which might arise in the hilar lymph nodes, such as Hodgkin's disease.

5. Emphysema over the remainder of the lung fields is almost invariably present.

6. The position of the lesions is usually longitudinal. The shape of these lesions does not form standard patterns, as may be seen with neoplasms or infarction, but their longitudinal position is helpful in recognition.

7. Confirmatory typical nodulation may be present.

8. The lesions in the separate lung fields incline toward a similar density and appearance. With primary carcinoma or tuberculosis on one side with spread to the other the appearance in the opposite lung field is different. The density may be much greater than with neoplasms.

9. Fibrous strands are frequently seen radiating outward from the lesions.

10. Diaphragmatic deformities are frequent. Limitation of diaphragmatic motion is common.

11. The trachea is usually in the midline.—*James J. McCort.*

Dunner, Lasar, Hermon, R., and Bagnall, D. J. T. Pneumoconiosis in dockers dealing with grain and seeds. *Brit. J. Radiol.*, Dec., 1946, *19*, 506–511.

In London many ships containing grain are unloaded. Previously the work was done by men and shovels, but recently suction apparatus has been used. Either method produces much dust which is necessarily inhaled by the workers. A group of 55 dock workers who had had more or less prolonged contact with such dust was examined, and of the total, 26 had active pulmonary tuberculosis. Of the rest, there were 11 cases of pneumoconiosis. These were carefully questioned to exclude the possibility of previous occupation in a dusty trade.

The kinds of grain handled were oats, barley, wheat, and maize, particularly; but there were also seeds, such as millet, cotton, dari, and rape. The worst grain for dust production was barley; the worst seed, cotton.

Samples of various dusts were examined for their silica (silicon dioxide) content. When the silica content is compared with that of dust known to be highly dangerous, it is seen that the dusts from these grains are potentially dangerous. No tubercle bacilli were found in the samples examined bacteriologically.

The diagnosis of pneumoconiosis was based on the roentgen findings rather than on clinical evidence for case finding. The ages of the eleven men with pneumoconiosis varied between thirty-six and fifty-nine years, and the duration of the occupation between two and forty years, with the average twenty-two. Most of these patients had had a cough for a long time, usually productive, had experienced dyspnea, with either a gradual or abrupt onset, and most were in good physical condition. The degree of dyspnea was not always consistent with the roentgen pulmonary findings. Likewise, there was considerable discrepancy between clinical signs and roentgenological manifestations. The roentgen findings were usually reticulation, mottling, fibrosis, or a combination of these, in any part of the lung.

The authors feel that the lesions are caused by the dust, but are unable to state which type of dust or what part of the dust causes the changes. They have demonstrated a dangerous amount of a known pathogenic agent.—*E. F. Lang.*

Scott, L. D. W., Park, S. D. Scott, and Lendrum, Alan C. Symposium; the clinical, radiological and pathological aspects of pulmonary haemosiderosis. *Brit. J. Radiol.*, Mar., 1947, *20*, 100–107.

Any pulmonary hemorrhage may result in deposition of hemosiderin in the lungs. It can be demonstrated roentgenologically in two conditions: pulmonary hemosiderosis of children, and mitral stenosis. A common occurrence in rheumatic heart disease with mitral stenosis is hemoptysis, and in some patients with a considerable degree of bleeding the focal deposits of hemosiderin may be demonstrable roentgenologically. The picture is that of miliary

deposits in the lung in rare instances. More often, in localized areas in the lung the faint deposits may be shown. In some individuals the deposits can be shown in roentgenograms of the lung after removal at autopsy when roentgenograms taken during life did not show them.

Occasionally the roentgen appearance is such that a diagnosis of miliary tuberculosis is suggested. Faint pulmonary hemosiderosis may be mistaken for vascular engorgement in congestive failure, but with improvement in the patient's clinical picture the vascular engorgement disappears while hemosiderin deposits persist. Other diseases which might give a similar appearance are pneumoconiosis, carcinomatosis, lymphangitis, sarcoid, bronchiolitis, miliary abscesses, leukemic infiltration, miliary chorionepithelioma, sarcomatosis, status lymphaticus, syphilis, and fungus infections of various kinds.—*E. F. Lang.*

Wood, David A., and Pierson, Philip H. Pulmonary alveolar adenomatosis in man; is this the same disease as Jaagsiekte in sheep? *Am. Rev. Tuberc.*, March, 1945, *51*, 205–224.

The authors report a case of histopathologically benign pulmonary epithelial adenomatosis occurring chiefly in the right lower lobe of a telephone operator, fifty-seven years of age. Dyspnea with an initial dry cough gradually becoming productive was a prominent feature of the disease. Clinically the pulmonary adenomatosis was confined to the right lower lobe for a year. Foci, however, were found in the other lobes upon postmortem examination.

Histopathologically, the most prominent feature found was the multicentricity of hyperplastic columnar epithelial cells lining the alveolar walls, showing all degrees of proliferation from single lining to papillary and cyst adenomatous arrangements. In all sections there was a striking preservation of alveolar stroma devoid of epithelial invasion. Only hyperplastic alveolar changes were found, none being present in the bronchi.—*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XIII. Incidental findings of isolated tuberculous foci in the lungs apart from the primary complex ("focal extension"). *Am. Rev. Tuberc.*, Feb., 1945 *51*, 91–132.

This study is based on detailed morphological analysis of tuberculous lesions in 6 children and 49 adults, including 3 cases of progressive primary tuberculosis in children and 1 case of active primary tuberculosis in an adult. In the remaining 45 cases with various causes of death the tuberculosis lesions were incidentally observed postmortem. In all of them, one or more additional focal lesions, apart from the primary complex, were found with the same histopathological structure and of either the same or only slightly smaller size as the primary focus. These additional lesions, whose post primary character was clear because the regional complex was missing, were located in various parts of both lungs, including the upper (apical and subapical) portions of the upper lobes.

Anatomical and topographical analysis of these lesions, especially of those found in a relatively recent state, suggests intrabronchial spread from one or more primary lesions in their early active phase as an important pathway. Grossly marked penetration from tuberculous hilar lymph nodes through the wall of the bronchus into the bronchial mucosa can also lead to focal lesions of primary focus character. In the majority of the cases studied there was no evidence of hematogenous tuberculosis. —*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XIV. Tuberculous lesions in the apical and subapical field in connection with primary tuberculosis. *Am. Rev. Tuberc.*, Feb., 1945, *51*, 133–171.

This morphological study was undertaken to determine how far clinical observations, suggesting that primary tuberculosis in adult life produces directly a more or less diffuse infiltration of the apical and subapical areas, could be supported by anatomical evidence obtained from detailed gross and histological analysis. Of 330 cases with various anatomical findings of tuberculosis, including 55 fatal cases of tuberculosis, localized tuberculous lesions from 1 to 5 cm. below the apex, without a recognizable primary focus, were present in only 6 instances. Thus this apparently primary tuberculous infiltration of the upper portions of one upper lobe proved a rather infrequent occurrence, below 2 per cent of the total incidence of tuberculous lesions found postmortem in 330 adult cases. If only the cases of acute or chronic fatal tuberculosis are included, this percentage is below 4.—*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XV. Restricted pulmonary reinfection. *Am. Rev. Tuberc.*, Feb., 1945, *51*, 172–200.

The anatomical and histological picture of true exogenous, reinfection, presented for the most part by lesions few in number or single, is described on the basis of complete morphological analysis in 28 cases. In all, the reinfection lesions were found incidentally postmortem and were of no clinical significance. In all there was a typical old primary complex present, with the primary focus and the corresponding regional lymph node lesions in a completely obsolete state, and with no sign of exacerbation in either the focus or the lymph nodes. There was no trace of old hematogenous tubercles anywhere, including the lungs, which could have been formed at the time of the first infection. In the absence of any complicating sequelae beyond the old, obsolete complex, the exogenous nature of the subapical and apical reinfection lesions appeared beyond doubt in these cases.—*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XVI. Progressive reinfection. Part 1. *Am. Rev. Tuberc.*, April, 1945, *51*, 321–350.

The anatomical picture in 18 cases of exogenous, progressive pulmonary reinfection tuberculosis is presented. In 15 of them 3 were the typical obsolete remnants of a primary pulmonary infection, in 1 a primary intestinal infection was present. In the remaining 2 cases primary focus or foci were obscured among multiple apical and subapical calcified tubercles of apparently post primary character; the hilar lymph nodes regional to these areas, however, were distinctly calcified, just as in any typical obsolete primary complex.

The anatomical-histological analysis of the entire material pointed in all cases to the exogenous nature of these post primary reinfection lesions. They were found in typical subapical and apical location in 17, and in the left lower lobe in 1 case. Lymphogenous spread from the progressive post primary reinfection lesions was pronounced in 10 cases out of 18; in some of them with massive caseation of the entire bronchomediastinal lymph node chain.—*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XVII. Progressive reinfection. Part 2. *Am. Rev. Tuberc.*, April, 1945, *51*, 351–388.

In this paper the anatomical findings in 12 cases of pulmonary reinfectious lesions combined with various forms of hematogenous tuberculosis are presented. The cause of death was not phthisic destruction of the lungs but hematogenous tuberculosis in all, including overwhelming miliary tuberculosis in 4, tuberculous meningitis in at least 3, tuberculoma of the brain, tuberculosis of the spine, tuberculous destruction of the adrenal glands and tuberculous serositis.

With one exception there was anatomical evidence of lymphogenous progression to the bronchomediastinal lymph nodes from the pulmonary reinfection lesions. In all cases except one there were obsolete remnants of a primary pulmonary or (in one case only) intestinal complex. No trace of a possible pathogenetic link between the obsolete first infection and the usually chronic fibrocaseous super- or reinfection lesions could be found.—*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XVIII. Additional observations on progressive primary pulmonary tuberculosis in adults. *Am. Rev. Tuberc.*, Aug., 1945, *52*, 155–163.

The anatomical findings in 7 cases of progressive primary tuberculosis in the young adult from twenty to thirty years are presented. They resemble closely the anatomical character of progressive primary tuberculosis in children including considerable lymphogenous spread from the primary lesion to the regional bronchomediastinal lymph nodes, cavitation of the primary focus followed by intrabronchial extension and overwhelming hematogenous miliary seeding with tuberculous meningitis. One unusual observation of caseated pleuritis contiguous to a recent primary parenchymal subpleural lesion—with but slight lymph node complex changes and with overwhelming miliary tuberculosis—is also included, and an apparently primary progressive phthisic form of pulmonary tuberculosis in a senile person, aged ninety-one, is added, suggesting that remnants of a primary complex may leave no grossly recognizable traces in later life, especially in senility. —*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XIX. Protracted pri-

mary tuberculosis in the adult, with some observations on "lymphoglandular-endogenous reinfection (Ghon)." *Am. Rev. Tuberc.*, Sept., 1945, *52*, 312–336.

The author states that the term endogenous reinfection was first used by Orth. According to Orth, it meant the manifestation of a new infection in a harborer of tuberculous lesions by the same tubercle bacilli which had infected the body originally. It is, therefore, in terms usually applied in general pathology, a recurrence. This term "endogenous reinfection" was amplified by Ghon (Ghon, A. and Pototschnig, G.: *Beitr. z. Klin. d. Tuberk.*, 1919, *40*, 103) with the adjective "lymphoglandular" referring specifically to the type which is caused by a local reactivation and extension with lymph nodes, the site of older tuberculous lesions, while the primary focus appears completely healed. It is thought to be immaterial in this discussion whether this reactivation of the tuberculous process followed a state of apparently long latency, as Ghon thought in his first publication on endogenous reinfection, or whether an exacerbation of the bronchomediastinal lymph node tuberculosis recurred in several phases.

The anatomical findings in 6 cases of primary protracted tuberculosis in adults are discussed. Four or possibly 5 of these represent changes of "endogeneous lymphoglandular reinfection" with hematogenous dissemination involving especially spleen, liver, kidneys, the lungs, pleura, peritoneum, and leptomeninges. A comparison of the entire anatomical picture in these cases with that seen in exogenous reinfection shows that the pulmonary lesions are clearly of hematogenous character and that they do not lead to further intrabronchial progression as seen in the common type of pulmonary tuberculosis.—*James J. McCort.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XX. Disseminated calcified small nodular hematogenous pulmonary tubercles, incidentally discovered. *Am. Rev. Tuberc.*, Dec., 1945, *52*, 505–520.

An incidental postmortem finding in a sixty year old white farmer who was said to have been always in the best of health and who was killed accidentally, revealed nearly 200 parenchymatous calcified and chalky tubercles in fairly even distribution in both lungs, with no predilection of the apical and subapical areas, in the presence of multiple calcified and fibrous tubercles in liver, spleen, and kidneys. This histopathological structure of the individual parenchymatous lesions does not permit any unequivocal interpretation in terms of pathogenesis without considering the anatomical picture in its entirety. The reported findings differ from those in "focal extension." The complete histopathological analysis of the parenchymatous pulmonary tubercles has disclosed various distinctive stages of structural regression between the soft chalky-fibrous, the chalky-calcified and the firm stony and calcified-ossified state. Together with the changes in the bronchomediastinal lymph nodes representing also various combinations of older and less old and possibly still active tuberculous lesions, they seem to point to protracted lymphogenous progression with repeated phases of hematogenous spread, leading to symmetrical dissemination of small nodular calcified and chalky-fibrous tubercles in both lungs.—*James J. McCort.*

Dormer, B. A., Friedlander, J., and Wiles, F. J. Bronchography in pulmonary tuberculosis. III. Chronic fibroid phthisis—chronic productive tuberculosis. *Am. Rev. Tuberc.*, Jan., 1945, *51*, 62–69.

The authors use a suspension of sulfonamide powder in lipiodol both in diagnosis and treatment. This combination is used in the belief that it may sterilize chronic bronchiectatic areas and cavities in cases of pulmonary tuberculosis in which the sputum has been positive for many years. It is suggested that this form of treatment should precede major thoracic surgery and that it may be a method of treatment for suppurative conditions of the lung.

Ten cases of chronic fibroid phthisis are described in which the authors used this method of diagnosis and treatment.—*James J. McCort.*

Dormer, B. A., Friedlander, J., and Wiles, F. J. Bronchography in pulmonary tuberculosis. IV. A geographical adventure. *Am. Rev. Tuberc.*, May, 1945, *51*, 455–462; June, 519–526.

This is a study of 16 patients examined by bronchography using iodized oil. The authors conclude that the most important factor in both pulmonary tuberculosis and septic infections of the lung is bronchial or bronchiolar block with the resulting atelectasis, cavitation or bronchiectasis and that the pathological processes of pulmonary tuberculosis are ade-

quately explained on this basis. It is also concluded that physical signs are not to be relied upon as accurate indications of a pulmonary process.—*James J. McCort.*

DORMER, B. A., FRIEDLANDER, J., and WILES, F. J. Bronchography in pulmonary tuberculosis. V. Artificial pneumothorax. *Am. Rev. Tuberc.*, July, 1945, *52*, 21–35.

The mechanism of artificial pneumothorax is explained as follows: In an artificial pneumothorax the collapse is from the periphery. Reducing the subatmospheric intrapleural pressure allows retraction of the diseased area, and large numbers of alveoli cave in. The general retraction and shrinking of alveoli and connective tissue prevent further infection and tend to squeeze liquefied tuberculous material out of the blocked bronchioles leaving them patent. This allows healing by fibrosis of the approximated thin walls of recent cavities and recent bronchiectasis in the actual area of disease. At the same time, the surrounding alveoli, which would also have become diseased if their bronchioles had remained blocked, are now able to expand and occupy the space left by the contraction of the fibrosed area. In other words, pneumothorax is effective because it eliminates the blockages in the bronchial system.

On the other hand, pneumothorax is of no therapeutic value in a case where the bronchial block persists in spite of the pneumothorax. If a bronchogram prior to an attempted artificial pneumothorax shows old-standing thick-walled ectatic bronchi or thick-walled cavities, then it is of no avail to carry on with this form of treatment, as the ultimate result will be that the bronchiectasis or the cavities will still be present. The authors have found by experience that artificial pneumothorax is not a treatment for chronic bronchiectasis of non-tuberculous origin as for chronic lung abscess and logically should not be effective, if the origin of the condition is tuberculous.

Artificial pneumothorax with superatmospheric intrapleural pressure is a relic of the days when it was thought that the lung should be collapsed in the literal sense of the word. If persisted in, upsetting complications arise, the two most bothersome being tuberculous empyema and bronchopleural fistula.—*James J. McCort.*

DORMER, B. A., FRIEDLANDER, J., and WILES, F. J. Bronchography in pulmonary tuberculosis. VI. Thoracoplasty. *Am. Rev. Tuberc.*, Aug., 1945, *52*, 145–154; Sept., 258–263.

The authors observe that the recent cavity which will not respond to artificial pneumothorax, especially a cavity in the upper part of the lung, is perhaps the ideal indication for thoracoplasty. The results in any other stage of tuberculosis cannot be predicted. Some cases emerge with a negative sputum, some with a positive, but one cannot say beforehand which case will attain a negative sputum and which will not. It is this very lack of the ability to predict the outcome of the operation that led the authors to study the bronchial tree in cases submitted for thoracoplasty and to study its reaction to each stage of the operation.

It is concluded that in a case with a single, relatively early apical cavity, which is the most suitable type for thoracoplasty, there may be no demonstrable bronchiectasis. In all other cases there is tuberculous bronchiectasis present before thoracoplasty and the bronchiectasis remains unchanged after the operation. It is this fact that makes it important to find some more logical form of therapy than thoracoplasty.—*James J. McCort.*

LODGE, THOMAS. The anatomy of the blood vessels of the human lung as applied to chest radiology. *Brit. J. Radiol.*, Jan., 1946, *19*, 1–13.

This thesis fully reviews the literature regarding the anatomy of the blood vessels of the human lung, giving a brief review of many previous investigations, and pointing out the lack of correlation between the anatomical and the roentgenological appearances of these vessels.

By the use of celloidin models, roentgenography of the lungs following the injection of the vessels with barium sulphate suspension, and tomography of the living subject, the writer translates the anatomy of the lung specifically into terms of chest roentgenology.

Lodge presents detailed descriptions of all main branches of the pulmonary vascular tree, adhering largely to Ewart's terminology with a few modifications. Schematic drawings and illustrations clarify the description.

The bronchial tree is also discussed as there is a strong interdependence of the bronchial and vascular systems. There is a constant relationship of artery, bronchus, and vein proceeding counterclockwise in that order in

the right lung and clockwise in the left lung in the same order. The veins tend to be distant from the bronchi and to lie in their interspaces. They cross the bronchi at an angle and are never parallel with them. They also cross arteries sometimes almost at 90°. Variations of the pulmonary vessels are particularly likely to occur in the upper lobes, while variations are rarely found in the bronchial tree.

The author's anatomical studies confirm the existence of such variations which he lists as (1) variation of origin, (2) duplication, (3) size, (4) direction. His study of 100 normal chest roentgenograms shows that many vessels can be identified and also gives some idea of the variations which may occur within the limits of normality. His studies also permit him to describe the following characteristics of a blood vessel shadow. The shadows present a homogeneous opacity diminishing gradually in caliber and maintaining their constant relationship to an accompanying bronchus. They are either straight or gently curved but never tortuous. The shadow shows clearly defined edges and obviously proceeds toward the hilum of the lung or corresponds to the direction of a known normal vessel.—*K. K. Latteier.*

Gross, Robert E., and Ware, Paul F. The surgical significance of aortic arch anomalies. *Surg., Gynec. & Obst.*, Oct., 1946, *83*, 435–448.

A brief résumé is made of the more common abnormalities of the aortic arch and the large arteries which arise from it. Many of the anomalies do not give important symptoms but others have considerable significance since they: (1) give rise to pressure on the esophagus and trachea; (2) impose a burden on the heart because of an arteriovenous type of shunt; or (3) lead to severe derangements in the circulation because of an obstruction in the aortic pathway.

1. In the first group of malformations under consideration, the esophagus or trachea (or both) are impinged upon by: (1) a right-sided aortic arch; (2) a double aortic arch; (3) a constricting ring of vessels (or remnants thereof); or (4) by an anomalous right subclavian artery.

2. *A right-sided aortic arch* cannot be changed by surgical means, but if this abnormally placed structure is attached by a ligamentum arteriosum (or a patent ductus arteriosus) to the pulmonary artery so that this latter vessel is pulled back against the trachea or the left side of the esophagus—then division of the ligament (or the ductus) should give some relief.

3. When a *double (or split) aortic arch* gives respiratory distress, the patient can be greatly helped by cutting the anterior (left) limb.

4. When dysphagia lusoria (dysphagia due to a lusus naturae—a trick or deception of nature) occurs from a *right subclavian artery (which originates from the left side of the aortic arch)*, the symptoms can be abolished by dividing the artery so that it no longer presses on the esophagus.

5. Humans with a *patent ductus arteriosus* are subject to certain hazards, particularly in mid-life. The shunt can greatly increase the work of the heart and lead to varying degrees of embarrassment or failure. Furthermore, the open ductus is frequently the seat of superimposed bacterial infection. While some individuals live a long and active life with a patent ductus arteriosus—particularly if it is a small one—statistics indicate that the average length of life is little more than half of the normal expectancy. Surgical closure of the ductus has been shown to have very beneficial effects on the cardiovascular apparatus. While surgery can be deferred until symptoms have developed, the technical difficulties of operation at such times is considerable. In contrast, the closure of a ductus at an early age can be accomplished with a negligible risk, and hence the authors recommend operation in childhood or young adult life before complications have developed. A widening experience in this field makes one feel that ligation of a ductus is usually satisfactory, but that complete division of the vessel is a much superior procedure because it insures complete interruption of the shunt and precludes any possibility of its re-establishment.

6. Individuals with a high degree of obstruction in the distal part of the aortic arch or in the first part of the descending aorta may live to advanced ages with little or no difficulty but most of then develop serious or even fatal complications in mid-life. Outstanding among the sequelae of *coarctation of the aorta* is hypertension which usually appears in the upper part of the body. With this increased pressure may come all of the disorders and dangers of the hypertensive state. Experimental observations show that a section of the upper thoracic aorta can be excised and that the open ends of the aorta can be satisfactorily joined. Such a procedure has been adapted to humans; a narrowed

(or completely obstructed) segment of the aorta can be removed and the remaining ends of the aorta can be anastomosed. After performance of this operation, the hypertension is quickly relieved.—*Mary Frances Vastine.*

Weiss, Morris, and Long, Leonard. Simple non-sphincteric localized esophageal spasm. *Am. J. Digest. Dis.*, Dec., 1946, *13*, 375.

Spasm of the upper end of the esophagus (cricopharyngeal spasm) and of the lower end (cardiospasm) are common entities. Spasm of the remainder of the esophagus is usually secondary to organic disease but simple nonsphincteric spasm does occur. It may be either localized or diffuse, the former type probably being the most common. Either type may occur in any portion of the esophagus and may be transient or prolonged. Although simple nonsphincteric spasm apparently is not frequently diagnosed, it probably is more common than the literature would indicate since the condition may be of very short duration and the symptoms too mild to require roentgenographic study. It may occur in any age group and both sexes are equally affected. The exact etiology is still in doubt. Nervous instability plays an important part; however, reflex stimulation from lesions of thoracic or abdominal viscera may also be exciting factors.

Either dysphagia or pain may be the outstanding symptoms, the pain varying from a dull substernal ache to severe shooting paroxysms and may lead to a diagnosis of angina pectoris.

In the reported case the patient's statement that he swallowed lye during childhood made appear on admission that this was an organic stricture of the esophagus. The roentgenographic examination at this time seemed to support this. But the history of previous attacks with asymptomatic intervening periods together with roentgenographic and esophagoscopic findings of obstruction that were transient in an individual with nervous instability indicates its functional nature. The lack of evidence of organic disease, intrinsic or extrinsic, supports this impression.

The case is unusual in that the spasm is localized in the upper third of the esophagus but below the cricopharyngeus. The symptoms are very similar to those seen in cricopharyngeal spasm and differentiation from it or organic obstruction would be difficult without roentgenographic and/or esophagoscopic examination.—*Franz J. Lust.*

Rafsky, Henry A., and Herzig, William. Scleroderma with oesophageal symptoms. *Gastroenterology*, Jan., 1946, *6*, 35–39.

It is well known today that scleroderma is recognized as the skin manifestation of a disease which affects several systems of the human organism. In the 2 reported cases, the skeletal, vascular and gastrointestinal systems showed typical alterations aside from the skin changes. The differential diagnosis may be confusing and misleading, depending upon the signs and symptoms presented at the onset of the disease. The first case showed circulatory impairment in the hands and feet initially which could have been interpreted as Raynaud's or Buerger's disease. The dysphagia, which appeared later on could lead one to suspect the patient had an idiopathic cardiospasm, a Plummer-Vinson symptom, neoplasm of the esophagus, a diverticulum or possibly a peptogenic disturbance. The patient finally presented almost simultaneously arthritic and skin changes which are frequently seen in osteorheumatoid arthritis.

The biopsy showed normal squamous cells. Perhaps the biopsy of the atrophic area did not penetrate deeply enough. The roentgen study of the esophagus showed that the lower half was markedly dilated with spasm (achalasia) at the cardia. Under the fluoroscope one could see the cardia relax after a while and the barium enter the stomach.

The findings were very similar in the second reported case.—*Franz J. Lust.*

ABDOMEN

Mendelsohn, E. A. Hiatus hernia of the stomach as a source of gastro-intestinal bleeding. *Radiology*, May, 1946, *46*, 502–506.

The hiatus hernia may or may not be combined with a congenitally short esophagus. Insufficiency of the muscular hiatus and of the surrounding connective tissue, acquired with advancing age, is considered the decisive etiologic factor.

The cause of bleeding in hiatus hernia is considered to be venous congestion in the herniated portion of the stomach due to muscular compression of the diaphragm. The swollen and congested mucosal layer can easily be traumatized with production of superficial bleeding erosions or deeper ulceration.

Sixteen cases of hiatus hernia of the stomach have been observed in 1,000 consecutive gastrointestinal examinations at the Sparks Memorial

Hospital and the Holt-Krock Clinic. Four case histories are given in detail demonstrating hiatus hernia of the stomach as the source of intestinal bleeding, manifesting itself in hematemesis, melena or microcytic anemia.

The symptoms of hiatus hernia may simulate coronary artery disease and intra-abdominal conditions.—*F. B. Markunas.*

Scott, W. G. Radiographic diagnosis of prolapsed redundant gastric mucosa into the duodenum, with remarks on the clinical significance and treatment. *Radiology*, June, 1946, *46*, 547–568.

Because gastric mucosa prolapsing into the duodenum is often diagnosed as duodenal ulcer or duodenitis and when recognized is considered of no clinical significance, Scott has reviewed the subject. His conclusions are illustrated by cases seen in the military service.

In a series of 1,346 successive roentgen examinagions of the upper gastrointestinal tract of young adult males, this condition was found as often as gastric ulcer. The etiology appears to be an excessive and abnormal mobility of the pyloric mucosa on the muscularis.

The symptoms are not sufficiently characteristic to permit a clinical diagnosis. The diagnosis depends on the roentgenologic findings and the ruling out of other gastrointestinal diseases. The roentgen findings are quite characteristic and consist of a central mushroom or cauliflower-like defect in the base of the duodenal cap. It is practically impossible to distinguish prolapsing mucosa from prolapsing pedunculated tumors or polyps.

The condition is treated surgically with excellent results. Symptoms such as bleeding and persistent pain in spite of dietary regulation are indications for surgery.—*J. H. Harris.*

Bank, Joseph, Pearce, Alexander E., and Gilmore, John H. Hypertrophic gastritis simulating neoplasm. *Am. J. Digest. Dis.*, Nov., 1946, *13*, 344–346.

The authors report the case of a twenty-six year old soldier who had been suffering from epigastric distress for several years. Before admission to the hospital he had lost 8 pounds. The examination of the gastric contents revealed a hyperacidity. Fasting free HCl 90, total acidity 110, highest postcibal acidity free 115, total acidity, 130. The roentgenological examination gave the impression of a large neoplasm in the region of the antrum of the stomach. No peristalsis in the involved area could be seen.

At operation, the surgeon had the impression of a polypoid tumor in the lumen of the stomach. A scar of an old prepyloric ulcer was found. The pathological examination showed large prominent rugae with extensive convolution. On section, the large folds showed a very thick mucosa, measuring up to 3.5 mm., with an exaggerated muscularis mucosae. The submucosa appeared greatly edematous. No neoplastic masses could be found.—*Franz J. Lust.*

Cash, I. I., and Rappoport, A. E. Reticulum cell sarcoma of the stomach. *Gastroenterology*, Jan., 1946, 6, 40–49.

A rare case of reticulum cell sarcoma of the stomach is reported. These cells are derived from the germinal centers of the lymphoid tissue located in the gastric submucosa. Clinically the symptoms are protean as in gastric carcinoma. Gastroscopically, the lesion appears not unlike that of an infiltrating lymphosarcoma. The lesion tends to ulcerate and infiltrate surrounding organs, and in this case, a "forme fruste" perforation was present.

The roentgenological examination revealed an extensive prepyloric lesion which appeared polypoid in nature with small and large filling defects in the distal third of the stomach and marked enlargement and distortion of the gastric rugal pattern over the small area proximal to this. Some peristaltic waves could be observed through this same area.

A subtotal gastric resection followed by irradiation is the therapy of choice. The prognosis is debatable, although the authors believe that five year cure is probable.—*Franz J. Lust.*

Tennent, William. Recent advances in investigation of the small intestine. *Brit. J. Radiol.*, Jan., 1946, *19*, 22–26.

Quite different techniques are required in examination of the small intestine with reference to study of the physiological activity and the search for organic lesions. In studying the physiological activity (as in celiac disease, idiopathic steatorrhea, and so-called deficiency diseases) a fractional barium meal is the technique of choice. Barium suspended in isotonic saline and heated to body temperature may, when taken orally at fifteen minute intervals, evenly fill the small intestine and allow study of the mucosal pattern, peristalsis, and absorptive capacity of the gut. The organic

lesions (as regional ileitis, neoplasm, and intestinal obstruction) are best investigated by means of intestinal intubation. The small intestinal enema administered by gravity through an ordinary rubber tube directly into the duodenum often allows steady filling of the small bowel in the same manner as with colonic enema. Though this method has frequently demonstrated adhesions, regional ileitis and pressure from extraluminal tumors, it is obviously dangerous to use in the presence of even partial obstruction. Frequently gastric reflux interferes with the examination. The injection of barium through a Miller-Abbott tube is much more satisfactory allowing localization of the site to be examined so that only small quantities of barium need be injected. The inflated balloon may be allowed to sweep the small amount of barium forward in front of it or it may be used to block the third part of the duodenum while barium is injected into the proximal duodenum and its contours studied. Two balloons can also be fitted to the same tube and used to isolate any particular segment of bowel.—*K. K. Latteier.*

DALLOS, ARTHUR. Roentgenological evidence of appendiceal abscesses. *Am. J. Digest. Dis.*, Sept., 1946, *13*, 279–284.

Dallos discusses the roentgenological findings in patients where appendiceal abscess started weeks or months after their acute abdominal symptoms had subsided or in which the patients could not recall any acute abdominal illness. These are cases of a chronic type in which as a result of a suppurative infection the appendix has been perforated and become walled off producing a localized abscess with tumor formation.

The author reports 5 such cases and draws the following conclusions for the roentgenological diagnosis: (1) filling defects, either extrinsic or intrinsic or both; (2) fixation of the cecum and last loop of the ileum; (3) elevation and displacement of the ileum; (4) hyperirritability and hypermotility with cecal spasm; (5) sensitiveness and tenderness of the area; (6) no visualization of the appendix.

The surgical procedure must be decided at the operation itself. In the reported cases, 1 had an appendectomy, 1 appendectomy with drainage of the abscess, 2 ileotransversostomy and 1 an ileocecal resection.—*Franz J. Lust.*

GAUSS, HARRY, and WEINSTEIN, L. J. Toxic sulfonamide colitis. *Am. J. Digest. Dis.*, Dec., 1946, *13*, 373.

Three cases of toxic sulfonamide colitis are reported following the oral administration of sulfathiazole in 1 instance and sulfapyridine in 2 instances. Although seen under different circumstances, the 3 patients presented singularly similar clinical pictures of the digestive tract complication. In all of them the colon was swollen and hemorrhagic to the full length of the 25 cm. scope. The patients all had a severe diarrhea with frequent hemorrhagic stools associated with severe abdominal cramps. With the withdrawal of the sulfonamides the symptoms subsided, and the colon returned to its normal appearance, leading to the conclusion that the hemorrhagic colitis was the direct result of the toxic effect of the ingested sulfonamide.—*Franz J. Lust.*

COGSWELL, H. D., and THOMPSON, HUGH C. Duplication of the rectum. *Am. J. Dis. Child.*, Feb., 1947, *73*, 167–177.

Duplications of the alimentary tract or, as they have been more commonly called, enterogeneous cysts or diverticula, are of great rarity, especially in the rectum. The case reported in this paper, according to the opinion of the authors, is unique in that the duplication of the rectum assumed the characteristics of both a cyst and a diverticulun during the time the patient was being observed.

The patient was a white girl, who on admission to the hospital at the age of seven weeks had considerable distention of the abdomen with an umbilical hernia. The feces were loose and yellow and occasionally contained blood. Roentgenologic studies showed a large air-containing sac of bowel, displacing the abdominal contents to the right and apparently arising from the pelvis. A lateral view showed that the splenic flexure and transverse colon were posterior to the cyst-like shadow. No communication between the colon and cyst could be demonstrated. The patient was operated upon. In commenting upon the operative findings, the authors state that the case offers argument in favor of designating the condition found as a "duplication" rather than as a cyst or diverticulum as both of the latter existed in this instance. At the time of operation a cyst (defined as any sac, normal or otherwise, especially one which contains a liquid or semisolid) was

found. After drainage, this was found to be unquestionably a diverticulum (a pouch, leading off from a main cavity or tube). The patient had most of the usual symptoms of duplication, namely, abdominal colic, distention of the abdomen, increased peristalsis and constipation with one exception, however, vomiting. The latter was most probably absent because of the low position of compression of the bowel.

An unusual feature was the presence of a large amount of air and later pus in the duplication. The authors suggest that there must have been some "trap door" or "ball valve" mechanism which allowed the passage of gas from the rectum into the duplication but prevented its escape. It would also appear that the greater the intraluminal pressure existing in the duplication, the less possibility there was of an escape of its contents into the lumen of the colon.

As defined by Ladd and Gross, duplications of the alimentary tract are hollow structures which possess a muscular coat and are lined with epithelium similar to that found in some portion of the gastrointestinal tract. They may arise in any portion of the tract from the tongue to the anus, the most common site being the ileocecal valve, and may present themselves in any position at the periphery of the intestine, that is, antimesenteric or mesenteric, often lying between the folds of the mesentery. Their position in the wall of the alimentary tract also varies in that they may be found in the subserous or submucous layers. The shape likewise is inconsistent and can be tubular or globular, so that a variable length of bowel (a duplication), blind on both ends, may exist in close proximity to the main intestine or even inside it. In those instances in which a communication exists with the neighboring intestinal tract, the contents will be usually similar to those in the intestine. Those without a communication to the lumen of the bowel, are cystic and contain a clear, colorless, mucoid substance.

The relief of the acute symptoms was effected by marsupialization of the duplication, and this procedure is recommended for cases of this type.—*R. S. Bromer.*

Comfort, Manfred W., Gambill, Earl E., and Baggenstoss, A. H. Chronic relapsing pancreatitis. *Gastroenterology*, April, 1946, *6*, 239–285; May, 376–408.

On the basis of 29 cases of chronic relapsing pancreatitis without associated disease of the biliary or gastroduodenal tracts of a degree sufficient to influence the clinical picture the following conclusions are drawn:

(1) Chronic relapsing pancreatitis appears to represent the summation of repeated attacks of acute interstitial pancreatitis or repeated sublethal attacks of so-called acute hemorrhagic pancreatitis or a combination of the two types of pancreatitis. Interstitial fibrosis and residual necrosis and atrophy are the constant chronic changes. Regions of calcification or stone, pseudo-cysts and abscess are less frequent but striking residua.

(2) Chronic relapsing pancreatitis characteristically is a disease of recurring exacerbations separated by short or long intervals of relative clinical quiescence. During the early stages of the disease, the clinician may not be able to demonstrate existence of pathologic physiologic changes, yet the surgeon or the pathologist will be able to demonstrate pathologic changes in the organ. However, later in the course of the disease, the destruction of the pancreas will reach the point where disturbances of internal and external secretion, pancreatic calcification and other sequelae will be demonstrable at all times.

(3) The clinical signs are recurring, prolonged attacks of severe pains in the upper part of the abdomen, and disturbances of function of the acinar and islet cells and certain sequelae. Disturbances of function may be transitory and mild during the acute episodes before widespread anatomic destuction has occurred. Glycosuria and hyperglycemia, steatorrhea and creatorrhea appear and persist. Pancreatic stones and calcification appear in roentgenograms of the organ and the enlarged organ and cysts may be felt.

(4) The clinical signs are due not only to the disease in the pancreas but also to the effect of the disease on neighboring organs. The most striking of these sequelae are obstruction of the common bile duct, jaundice, hepatitis, distention of the gallbladder and obstruction of the duodenum.

(5) The treatment of choice is surgical. The results of conservative surgical procedures (internal or external drainage of the biliary tract and pancreatic cysts, pancrealithotomy, or gastroentrostomy for duodenal obstruction) are sufficiently good to warrant frequent and early use. Radical surgical procedures (partial or total pancreatectomy) may be utilized if the

conservative ones have failed and then only for the relief of persistent pains. Medical measures include diet, replacement therapy, drugs for control of pain and measures in case of shock.—*Franz J. Lust.*

GYNECOLOGY AND OBSTETRICS

Jefferiss, D., and Samuel, Eric. Pelvigraphy. *Brit. J. Radiol.*, Nov., 1946, *19*, 462–468.

Kjellberg introduced a method of examination of the female pelvis with a water-soluble contrast medium as is used in excretory urography. The material is injected into the uterus and tubes through a uterine catheter, under roentgenoscopic control. When the uterus and fallopian tubes are outlined a film is made which gives the same information as the conventional examination with lipiodol. After this, more material is injected, and the serosal wall of the uterus, the ovaries, the pouch of Douglas, and the broad ligaments may be identified. Anteroposterior films are made with the patient supine and in each lateral decubitus.

In the face of a hydrosalpinx, a satisfactory lipiodol salpingogram is usually not obtained, because of the viscosity of the medium. Water-soluble dye mixes with the fluid in the tube and in some views even layering of the two fluids may be observed. By this method ovarian tumors are easily outlined, as are tumors of the peritoneal aspect of the uterus. In lateral views the thickness of the uterine wall can be outlined between the two layers of opaque medium. Tumors in the broad ligaments may be outlined as space occupying defects, or by their displacement of the uterus or distortion of the tube on that side.

The opaque medium is rapidly absorbed from the peritoneal cavity, and the procedure is no more dangerous than an excretory urogram from the standpoint of toxicity of the medium. The method is of course contraindicated in patients with recent pelvic inflammatory disease.—*E. F. Lang.*

Allen, E. Peter. Standardised radiological pelvimetry. I. Quantitative aspects. *Brit. J. Radiol.*, Feb., 1947, *20*, 45–54.

Two of the factors preventing proper assessment of the importance of roentgen pelvimetry at present are the variation in the methods and the variation in the bases of interpretation. Each author stresses his own method, and each decides which features of the pelvis are of obstetrical significance. Comparison of any two methods is therefore difficult. An acceptable standard system of pelvimetry should be capable of measuring all the significant pelvic diameters with sufficient accuracy to be useful. It must use standard apparatus. It should be simple enough for one not trained in mathematics, and it must be concise and objective enough to be accurate in the hands of an inexperienced radiologist.

Considerable variation in opinion exists as to which diameters to measure. The major problem is clarification of the status of the true or obstetrical conjugate. Many authors have questioned the importance of the anterior upper margin of the sacrum as the posterior end-point, and these would place the end-point where the iliopectineal lines would meet if extended. This would place it in the plane of the widest transverse diameter of the brim and would thus represent the "available" anteroposterior diameter, according to Caldwell and Moloy. The author examined 12 dried female pelves and found that in only a minority of cases do these two lines lie in the same plane. The point on the anterior portion of the sacrum to be taken as the posterior point of the conjugate should be that point which is closest to the symphysis pubis. In patients with an acute pubosacral angle this point may be as low as the lower part of the first sacral body. In the usual case, however, with a pubosacral angle of 90 degrees or more, the sacral promontory is more nearly correct.

Other measurements of the inlet are not so important. The end-points of the transverse diameter are definite. The number of other measurements of the brim should be reduced to a minimum, since the head is available as a pelvimeter in most cases.

In measurements of the midplane of the pelvis, the significant transverse diameter is usually taken as the interspinous. Actually, however, there is considerable space anterior to this which is available to the descending head if the interspinous diameter is narrow. In this case, the head takes the path of least resistance and then the narrowest available diameter at that level is that between the flat bodies of the ischia anterior to the spines. The anteroposterior diameter should be measured from the lower part of the symphysis to the lowermost fixed sacral segment.

Measurement of the outlet is difficult because of the lack of definite end-points. The most im-

portant consideration from the standpoint of roentgen pelvimetry is measurement of the subpubic angle. This measurement is best made with the patient sitting on the film.

A subsidiary method of pelvimetry is calculation of the area of the inlet. This is an important method of consolidating the anteroposterior and transverse measurements which are given in linear dimensions. It is most useful in generally contracted pelves when the inlet remains a circle or a regular ellipse. When the inlet is flat or wedge-shaped with a considerable difference between the two diameters, the area may be misleading.—*E. F. Lang.*

Allen, E. Peter. Standardised radiological pelvimetry. II. Qualitative. *Brit. J. Radiol.*, Mar., 1947, *20*, 108–118.

The shape of the pelvis, as distinguished from the size, is an important factor in the course of labor. Systems of classification have relied almost entirely on the brim measurements because these diameters are most easily measured, and are the most important, obstetrically. In order to define a pelvic type exactly, it must be described mathematically rather than as a sense impression of shape.

There have been four important different systems described. In 1885 Turner classified pelves according to the ratio between the anteroposterior and transverse diameters of the brim. Thoms extended this by using instead of the ratio the actual difference between the two measurements. Caldwell and Moloy use four main types and ten subtypes in describing the pelvis, and the approach is through sense impressions of shape without an exact mathematical basis. In 1942 Steele and Javert modified the work of Caldwell and Moloy by specifying normal diameters and they devised a set of semigeometrical figures for superimposition on a roentgenogram.

The author has examined these systems in some detail, and finds each wanting. The best compromise, he feels, is some expression of ratios between the five diameters of the pelvic brim with limiting values describing the four main types.

The android type of pelvis is most satisfactorily described as having a ratio of less than 40 per cent between the posterior sagittal and the conjugate diameters. Suggested other standards are: round pelvis has a brim index of 85 to 100 per cent; long oval pelvis has a brim index over 100 per cent; flat pelvis has a brim index under 85 per cent. Any of these may have android posterior segments.

It should be realized that greatest advantage to the patient can be achieved by actual consultation between the obstetrician and radiologist while viewing the films.—*E. F. Lang.*

GENITOURINARY SYSTEM

Deming, C. L. The prognosis and problems in renal tumors. *J. Urol.*, June, 1946, *55*, 571–582.

This article summarizes a detailed study of 82 renal tumors seen in the New Haven Hospital in twenty-three years. The author found that only 13.4 per cent of his series of cases occurred in children in contrast to the commonly quoted figures of 30 per cent. Of the 11 cases occurring in children only 3 were Wilms' tumors. His figures also show a 19.5 per cent survival rate at five years, one-half of whom were free from disease.

The usual sites of metastases are the lungs, liver, lymph nodes and the opposite kidney in that order.

In regard to treatment, the author states that irradiation may reduce the size of the tumor in some cases increasing the feasibility of surgical removal of the tumor. It also may cause temporary disappearance of metastatic lung nodules but he feels that the value of this is outweighed by the production of fibrotic pneumonitis. Irradiation should not be employed without a histopathologic diagnosis of a tumor which is radiosensitive.

The survival rate did not seem to vary significantly in those with immediate treatment and those in whom there was a delay in diagnosis and treatment.—*Rolfe M. Harvey.*

Nesbit, R. M., and Adams, F. M. Wilms' tumor; review of 16 cases. *J. Pediat.*, Sept., 1946, *29*, 295–303.

The survival rate for cases of Wilms' tumor has been reported as uniformly low. The best previously reported survival figure was that of Ladd and White, who reported a two year survival of 23.3 per cent. The authors report a series of 16 cases with a three and one-half year survival rate of 50 per cent. Seventy-five per cent of their cases were under three years of age.

Wilms' tumors are usually silent and are discovered accidentally by the nurse or mother of the child who notices the presence of an abdominal mass. Symptoms of weight loss, pallor,

vomiting and pain mean delay in seeking medical advice. The diagnosis should be suspected from the history of progressive enlargement of the abdomen in a child under five and the finding of a firm non-tender mass in the abdomen. The greatest difficulty in diagnosis is from an adrenal neuroblastoma. The diagnosis can be confirmed by pyelography. The characteristic changes in the pyelogram are: (1) distortion of the renal pelvis and calices, (2) displacement of the renal pelvis, and (3) non-visualization of the renal pelvis.

Methods of treatment vary. The authors believe preoperative irradiation should be used only when the size of the tumor makes operative removal a difficult technical procedure. All patients should be given postoperative irradiation.—*Rolfe M. Harvey.*

AUERBACH, O., BRINES, O. A., and YAGUDA, A. Neoplasms of the testis. *J. Urol.*, Sept., 1946, *56*, 368–374.

In a three year period at a Naval Hospital which had 150 beds devoted to treatment of malignant disease 26 autopsies were performed on patients who died of testicular malignancy, an incidence of 20 per cent of all deaths from malignancy. The ages ranged from nineteen to fifty years. History of preceding trauma was rarely noted. The duration of life following establishment of the diagnosis varied from two to twenty-two months and varied inversely with the duration of the disease before the diagnosis was made.

Twenty-three of 26 cases were subjected to an orchidectomy. All cases received postoperative irradiation. This was given to the chest, abdomen and any enlarged nodes noted in the axillary and supraclavicular regions.

The commonest presenting symptom was painless enlargement of the testis. In 92 per cent of cases a large palpable mass was present at the level of the celiac axis due to retroperitoneal nodes. In 79 per cent of cases the liver was the seat of metastases. In 80 per cent of cases the mediastinal lymph nodes were involved. Metastases were present in the lungs in 85 per cent of cases.

Various classifications of testicular tumors are discussed.—*Rolfe M. Harvey.*

NERVOUS SYSTEM

ULMER, JACK L., and MAYFIELD, FRANK H. Causalgia; study of 75 cases. *Surg., Gynec. & Obst.*, Dec., 1946, *83*, 789–796.

The data from 75 cases of causalgia due to war wounds of large mixed peripheral nerves have been presented and the following conclusions are drawn.

(1) The pathologic mechanism is obscure.

(2) The disorder is characterized by burning pain in association with vasomotor disturbances in the distal part of the extremity.

(3) The vasomotor disturbances are of two types, vasoconstriction or vasodilatation. The possibility that the vasomotor state may vary in any case is recognized but has not been observed.

(4) The pain can be relieved by appropriate sympathectomy. The sympathectomy must be complete, however, and with lesions involving the upper portion of the sciatic nerve, removal of the sympathetic chain as high as the eleventh dorsal ganglion may be required. For lesions of the upper extremity preganglionic operation is adequate.

(5) Procaine block of the appropriate chain is a necessary diagnostic procedure.

(6) Repeated procaine block as a therapeutic agent has not been effective in the authors' hands. Certain patients have improved with this procedure, but none has been completely relieved.

(7) Resection of the injured segment of nerve will provide relief. Neurolysis and periarterial sympathectomy at the level of the injury are ineffective.

(8) Sympathectomy should be done as soon as the diagnosis is established, to prevent the psychic trauma of prolonged pain and crippling joint stiffness.

(9) Causalgia has been noted only with incomplete nerve lesions.

(10) Recovery of function is often rapid after relief of pain. Consequently, primary neurorrhaphy is rarely indicated.—*Mary Frances Vastine.*

SKELETAL SYSTEM

COSS, J. A., JR., and BOOTS, R. H. Juvenile rheumatoid arthritis; study of 56 cases with a note on skeletal changes. *J. Pediat.*, Aug., 1946, *29*, 143–156.

The authors have observed 56 cases of rheumatoid arthritis in children since the organization of their clinic in 1928. They have discarded the term Still's disease since they do not consider it a separate entity from rheumatoid arthritis. The diagnosis depends on the presence of periarticular changes such as swelling, con-

tractures, loss of motion, joint effusions, characteristic roentgen changes, muscle atrophy, subcutaneous nodules, enlarged lymph nodes, splenomegaly and hepatomegaly, persisting over a period of years with or without associated systemic changes.

In the authors' series of cases the ratio of females to males was 5:1, the same as the adult ratio. Fifty-seven per cent of cases had a history of respiratory tract infection in association with the arthritis or preceding it; 60 per cent of cases had generalized glandular enlargement. Practically all patients complained of pain at some time during their illness. Forty-seven per cent had some cardiac disturbance; 80 per cent had a moderate anemia. In general, the higher the leukocytosis, the poorer the prognosis.

The authors have used four criteria in the roentgen diagnosis of skeletal changes in juvenile rheumatoid arthritis: (1) decalcification, (2) bone destruction, (3) joint space narrowing, and (4) soft tissue changes. Roentgen evidence of joint changes, as in adults, appears late. In general, the roentgen picture is similar to that in adults.

Among interesting changes noted in their series were fusion of cervical vertebral bodies which suggested failure of segmentation but which was proved to be fusion by referring to earlier films which were normal, brachydactylia and brachygnathia.

The authors conclude their report with illustrative case abstracts.—*Rolfe M. Harvey.*

Leonard, D. W., and Cohen, L. Nonrachitic bowlegs in childhood; osteochondrosis deformans tibiae. *J. Pediat.*, Oct., 1946, *29*, 477–484.

Many medical men are inclined to attribute bowing of the legs in childhood to rickets alone. However, the syndrome of tibia vara or osteochondrosis tibiae deformans must not be forgotten in the differential diagnosis. Blount first described this entity and differentiated it from rickets, Ollier's dyschondroplasia, syphilis, tuberculosis and osteochondritis. The syndrome has been divided into an infantile and an adolescent type.

The bowing occurs as an abrupt angulation just below the tibial condyles, the shaft of the tibia being straight beyond the point of angulation. On physical examination an enlargement of the medial condyle can be palpated. The medial condyle is prominent on the roentgen film as a beak-like projection. The deformity has been attributed to delayed ossification of the medial half of the upper tibial epiphysis.

The authors include a chart to aid in differentiating the condition from rickets and Ollier's dyschondroplasia. He emphasizes the normal epiphyseal line in tibia vara which, however, would not help in differentiating a healed rickets. Most of his differential points appear concerned with an active rickets, which, in the reviewer's mind, would not present the problem that a healed rickets with bowing would present.

The article is concluded with a discussion of the orthopedic management of the condition.—*Rolfe M. Harvey.*

Murray, Gordon. End results of bone-grafting for non-union of the carpal navicular. *J. Bone & Joint Surg.*, Oct., 1946, *28*, 749–756.

Gordon reports the results in 100 cases of bone-grafting for fractures of the carpal navicular. Bony union occurred in 96 patients. In some patients the range of motion was 100 per cent in all directions without any disability or discomfort. In some of the others, where there had been prolonged non-union and where a doubtful amount of arthritis was present in the wrist, the range of motion did not return to normal. However, the range of motion was useful and painless, and was sufficient so that the patients were able to return to their original work without discomfort or disability. The grafted navicular had a healthy appearance on roentgen examination as long as sixteen years after operation.

He enumerates six principles which must be followed to obtain the best results. The contraindications for operation for non-union of the navicular he states are (1) practically all early fractures, if splinted adequately will unite, so that bone-grafting for recent fractures is not a necessity; (2) in fractures in which non-union has existed for such length of time that there is arthritis in the wrist, disappearance of the articular cartilage between the navicular and the radius, or elongation of the styloid process of the radius, grafting should not be done. Even though the bone should unit solidly, the disability due to the arthritis in the wrist will not be corrected.

The presence of aseptic necrosis of the proximal fragment is not a contraindication, but is an absolute indication for bone-grafting, provided generalized arthritic changes are not present in the wrist. With grafting, the devitalized frag-

ment becomes revascularized and the fracture unites in most cases. One essential reason for doing a bone-graft in non-union of fracture of the navicular is that, if the non-union continues for a long period of time, arthritis of the wrist joint develops.—*R. S. Bromer.*

Zaglio, Edmond R., and Harris, M. H. Deformity of the radius produced by an aneurysm. *J. Bone & Joint Surg.*, July, 1946, *28*, 635–638.

The authors report a type of deformity caused by injury sustained in World War II which to their knowledge has not previously been reported. The patient was a soldier, aged twenty-two, wounded through the right forearm by machine-gun fire. Roentgenographic examination about twenty-four hours after the injury showed marked comminution and fragmentation of the right radius, the fragments describing an even arc. At operation, an aneurysm was found which had not been previously suspected.

The authors draw the following conclusions: (1) uniform deformity of a bone such as was seen in the roentgenogram should suggest the presence of an aneurysm; (2) the deformity achieves maximum size immediately after the injury; (3) the two lesions may be corrected at the same time.—*R. S. Bromer.*

Barnard, Leonard B., and McCoy, S. Murray. The supracondyloid process of the humerus. *J. Bone & Joint Surg.*, Oct., 1946, *28*, 845–850.

The presence of an anomalous spur, the authors state, on the medial aspect of the lower third of the humerus in approximately 1 per cent of people of European ancestry has long been known to anatomists, anthropologists and zoologists. However, its occurrence with a well defined clinical syndrome has received very little attention in the medical literature of the English-speaking countries. They report 3 cases together with a review of the anatomy and pathological findings discussed in the literature.

The supracondyloid process, when present, is often associated with a tendinous band, which is attached to the medial epicondyle, and with an anomalous origin of the pronator teres. It can cause a syndrome characterized by pain, radiating from the shoulder to the area of the median nerve of the hand. The pain is increased by pronation of the extended arm.

The diagnosis is easily made by palpation, but routine anteroposterior or lateral roentgenograms may fail to show the spur, because of its position on the anteromedial aspect of the bone. An oblique view may be required to demonstrate it.

In resection of the bony spur, the authors emphasize the fact that removal of the periosteum of the spur and the binding fibers of the pronator teres should be done to prevent regeneration of the spur and the recurrence of symptoms.—*R. S. Bromer.*

Urist, Marshall R. Complete dislocations of the acromioclavicular joint; nature of the traumatic lesion and effective methods of treatment with an analysis of forty-one cases. *J. Bone & Joint Surg.*, Oct., 1946, *28*, 813–837.

This paper is a very complete report and analysis of 41 cases of complete dislocation of the acromioclavicular joint. Mechanism of the injury, experimental observations, examination of resected joints, special tests of value during treatment, evaluation of symptoms, various methods of treatment, end results and complications and sequelae are discussed under sepate headings.

In the summary of the paper, Urist states that calcification and ossification, observed with the aid of soft-tissue roentgenographic techniques, were found in the region of the conoid and trapezoid ligaments in approximately half of the series of 41 cases. He regards this phenomenon as a part of the healing of the ligaments. It is important to evaluate possible anatomical variations from the supposed normal joint structure which may determine the success or failure of conservative treatment and the incidence of sequelae. Complete dislocation may occur with, or more often without, gross rupture of the coracoclavicular ligaments. Excision of the outer end of the clavicle, used successfully in 9 cases of the series, is regarded as apparently the most uniformly successful method of treatment for both recent and old complicated acromioclavicular dislocations.

Two observations of possible and prognostic importance were noted in the course of the study, although the limited number of cases does not permit positive statements concerning them at this time: (a) An increase in the width of the joint space on the injured side, demonstrated roentgenographically, indicates posterior displacement of the outer end of the clavicle, even when the acromion process and

the clavicle are correctly aligned. (b) Palpable posterior displacement and abnormal mobility of the outer end of the clavicle, after three weeks of healing, indicate the probable failure of conservative methods and the recurrence of the dislocation.

In 2 cases of the series, so-called avascular necrosis or osteochondritis was observed. In both cases, subchondral fractures were found at open operation. Avascular necrosis is not frequent, but should be expected in severe cases, as demonstrated by the roentgenograms, whether or not reduction has been accomplished.

The paper contains a very complete bibliography.—*R. S. Bromer.*

Finch, A. D., and Roberts, W. M. Epiphyseal coxa valga. *J. Bone & Joint Surg.*, Oct., 1946, *28*, 869–872.

Two cases of epiphyseal coxa valga are reported. Many articles on epiphyseal coxa vara or slipping of the capital femoral epiphysis in adolescents, with a residual varus deformity, have been published since the latter part of the nineteenth century. Apparently, however, no case of epiphyseal coxa valga in the presence of a morphologically well formed acetabulum has been reported in the English literature, although Müller in 1926 reported the development of coxa valga with epiphyseal slipping in cases of hypoplastic, flattened, or almost vertical acetabula. The condition is not mentioned in standard textbooks. A study of 100 cases of slipped capital femoral epiphyses, treated at the North Carolina Orthopedic Hospital since 1921, disclosed only 2 patients with a valgus deformity. This apparent rarity of epiphyseal coxa valga warranted, the authors believe, the report of these cases.

The roentgenograms which are reproduced illustrate clearly the displacement of the capital femoral epiphyses with the coxa valga deformity. The authors draw attention to the fact that use of the conventional or Whitman type of reduction by forcible internal rotation is contraindicated, as it probably increases the displacement of the head of the femur and favors the development of avascular necrosis.—*R. S. Bromer.*

Somerville, E. W. Air arthrography as an aid to diagnosis of lesions of the menisci of the knee joint. *J. Bone & Joint Surg.*, July, 1946, *28*, 451–465.

Somerville reports the study of a series of 331 examinations of the knee joint by air arthrography. The technique used combined the more important features described by previous workers. While the basis of the technique remained the same in all cases, many variations in detail were tried and improvements were made from time to time.

His technique is explained with excellent illustrations. The portion of the paper devoted to roentgenographic interpretation is also profusely illustrated with roentgenograms and specimens of menisci removed at operation. Examples of the various types of lesions are shown such as "bucket handle" tears, lesions of the anterior and posterior horns, persistent remnants of posterior horns, contused menisci, "tag" lesions, discoid menisci and "hypermobile" lesions.

Other lesions than those of the menisci can be demonstrated with less accuracy. Erosions of the articular cartilage are only demonstrable when the erosion is deep and extensive. In his series, only 2 cases of non-osseous loose bodies were shown. Osteochondritis dissecans can be seen more distinctly with air in the joint but in all cases the diagnosis had already been established by straight roentgenograms. Following air injections, the semimembranosus bursa can frequently be palpated clinically and has been found in a number of knees in which its presence had caused no symptoms. In one knee, a semimembranosus bursa was seen which contained a loose body.

Somerville concludes that in a large majority of injuries of the menisci, the diagnosis can be made on clinical grounds alone. Air arthrography is, however, useful as an aid to diagnosis, particularly in mixed lesions, such as tears of the anterior cruciate ligament associated with tears on the menisci, or simultaneous lesions of both menisci. The diagnosis of lesions of the medial meniscus is simpler than that of lesions of the lateral meniscus. Arthrography is of less value in the diagnosis of other lesions of the knee joint. It affords interesting information regarding the movements of the menisci during flexion and extension of the knee. These movements can be studied both with roentgenograms and by the fluoroscope. When the knee is flexed, the medial meniscus tends to be drawn backward out of the joint, and for this reason is not trapped.

Although the injection of air into a joint may produce a transient effusion, this is in no way harmful. Arthrography is a safe and simple procedure when done with full aseptic precautions.

Since the conclusion of the series, a technique has been devised for outlining the articular cartilage of the patella and the adjacent cartilage of the femoral condyles. The knee is filled with considerably more air than is used for other views. The compression bandage is applied above the knee, and the knee is flexed over the curved stand, illustrated in the portion of the paper on technique, to the greatest extent possible without obliterating the patellar tip. With an ordinary occlusal film pressed hard into the patellar ligament immediately above the tibial tuberosity, a roentgenogram is then made.—*R. S. Bromer.*

Guri, J. Puig. Treatment of painful spondylolisthesis. *Surg., Gynec. & Obst.*, Dec., 1946, *83*, 797–806.

In cases of painful spondylolisthesis a complete relief of the symptoms was obtained in 41.1 per cent of the patients treated conservatively and in 69.2 per cent of the cases treated by spinal fusion.

In no instance was a definite progression of the deformity observed after the treatment by means of braces or posterior spinal fusion had been undertaken.

Surgical procedures that endanger the life of the patient are not justified either from the view of the relief of the symptoms, or in order to check the progression of the deformity.

The presence of a sciatic pain associated with the local spinal symptoms does not necessarily mean that permanent relief cannot be obtained unless the disc is removed or curetted. In 55.5 per cent of the cases presenting such a clinical picture, complete relief was obtained either by conservative means or after the fusion of the posterior spine.

In advanced cases of spondylolisthesis the spontaneous fusion of the anterior spine after destruction of the intervertebral disc did not constantly produce complete relief of the symptoms. On the other hand, following the application of a spinal support or the surgical fusion of the posterior spine, all the symptoms disappeared.—*Mary Frances Vastine.*

Haas, S. L. Fusion of vertebrae following resection of the intervertebral disc. *J. Bone & Joint Surg.*, July, 1946, *28*, 544–549.

Opportunity for direct study of vertebral bodies after removal of the intervertebral disc is not available. Roentgenographic examination may be inconclusive as minute changes are not discernible. It is known that bony fusion does not always take place after resection of the articular cartilage of other joints. Because study in animals seemed warranted, Haas performed a series of six experiments upon dogs.

Commenting on the results, he found that complete bony bridging occurred between the bodies of the vertebrae of dogs after the intervertebral discs had been removed. The bone proliferation was more active in young animals. When firm osseous union took place, the combined length of the two vertebrae which had been operated upon was less than before operation; when union was not completely osseous, there was no diminution in length. With bony union, buckling toward the spinal canal tended to occur, which might account for some loss of length. Haas feels that if a disc operation is performed upon a growing individual, the possibility of retardation of growth with resulting deformity of the spine should be taken into consideration.

He found that in removal of the disc from the abdominal side, there was evidence of injury to the dura and cord. Likewise, in the dorsal approach there was danger of injuring the large vessel on the abdominal side. After the intervertebral disc had been removed, there was no gross evidence of displacement of the articular facets. None of the operations were performed by the dorsal spinal approach, but nevertheless, Haas states that it can be predicated from the results of his experiments that, in dogs, if the disc is thoroughly removed so as to expose the bone on either side, osseous union will take place between the two bodies. The method of union is similar to that observed in the healing of fracture in a long bone.—*R. S. Bromer.*

La Chapelle, E. H. Osteotomy of the lumbar spine for correction of kyphosis in a case of ankylosing spondylarthritis. *J. Bone & Joint Surg.*, Oct., 1946, *28*, 851–858.

La Chapelle reports a case of a patient with ankylosing spondylarthritis on whom he performed an osteotomy of the lumbar spine for correction of a kyphosis. In his introduction to the paper he states that gradual or manipulative correction of kyphosis in cases of advanced ankylopoietic spondylarthritis has been widely employed for many years with discouraging results. Corrections have been uniformly incomplete. They were not without danger and

eventually the deformity almost always recurred. His patient's urgent wish to become erect and his otherwise healthy, vigorous condition promoted the author to devise a method of operative correction through section of both the anterior and posterior elements of the vertebral column. The operation, when performed on the cadaver, gave promise of being safe and feasible and it proved to be effective in achieving correction. He then successfully performed it upon the patient whose case is reported in this paper. Satisfactory correction was obtained without untoward incident and the result two years later was gratifying.

The operation was performed in two stages. The first involved the removal of the laminae of the second lumbar vertebra and of the posterior articulations between second and third lumbar vertebrae. The second stage of the operation was performed through an anterior approach, and consisted of the excision of the second intervertebral disc, correction of the angulation of the spinal column and fixing of bone grafts in the gap between the two vertebrae.

The paper is illustrated with roentgenograms of the spine before operation and the result shown at eleven and also twenty-five months after operation.—*R. S. Bromer.*

Van Demark, R. E., and McCarthy, P. V. Panner's metatarsal disease; a condition of aseptic necrosis simulating march fracture. *J. Bone & Joint Surg.*, Oct., 1946, *28*, 842–844.

Subperiosteal stratification of the distal shaft of a central metatarsal bone is generally regarded as roentgenographic evidence of a march fracture when it first appears, in the absence of distinct recent trauma, in a young infantry recruit who suffers with a painful foot. The authors note that a similar subperiosteal stratification may be associated with a varying degree of aseptic necrosis of the adult metatarsal head. Watson-Jones has pointed out the resemblance of the latter condition to march fracture. Although the name of Panner is associated with the condition of subperiosteal stratification, Köhler had previously described the thickening of the distal portion of the diaphysis. Freiberg's illustrations also showed thickening although this feature was not specifically discussed.

A case is reported with serial roentgenograms illustrating the subperiosteal stratification with later somewhat cystic change in the head of the affected metatarsal. The differentiation of Panner's disease from march fracture is essential from both prognostic and therapeutic viewpoints. A certain rigidity and mild pain persist in the affected metatarsophalangeal joint as a result of aseptic necrosis of the metatarsal head. Patients with this condition do not respond to the ambulatory type of treatment which has proved satisfactory in most march fractures.—*R. S. Bromer.*

Bonnet, W. L., and Baker, D. R. Diagnosis of pes planus by x-ray. *Radiology*, Jan., 1946, *46*, 36–45.

This article is of particular interest to those radiologists who are working with orthopedists. It is pointed out that the diagnosis of pes planus can be made more accurately with properly taken and measured films than by clinical methods. The pedogram (footprint) does not give the true descent of the arch.

A lengthy discussion of the mechanism of the production of pes planus is given. The roentgenologic criteria of the condition are (1) an elongated second metatarsal as compared with the first; (2) broadening of the shaft of the second metatarsal as compared with the fourth; (3) increased separation between the internal and middle cuneiforms; (4) sesamoids over the middle metatarsal located proximal to the head.

The authors used the height of the outer longitudinal arch during repose and weight bearing. The amount of pronation was determined by a special double exposure made in the anteroposterior projection.

They conclude (1) that many persons having a normal appearing arch may have a basis for their symptoms if examined by the roentgen ray; (2) that "Morton foot" (short first metatarsal, etc.) may or may not co-exist with roentgen evidence of pes planus; (3) that pes planus is an important physical condition resulting in far reaching body changes and should be given more recognition by both radiologists and the general medical profession.—*J. H. Harris.*

Bickel, William H., and Dockerty, Malcolm B. Plantar neuromas, Morton's toe. *Surg., Gynec. & Obst.*, Jan., 1947, *84*, 111–116.

The affliction formerly called Morton's toe

or Morton's metatarsalgia has its pathologic basis in a tumefactive perineural fibrosis of the fourth digital nerve of the foot. Degenerative as well as proliferative nerve changes along with a neural and perineural edema are additionally present. The lesion may affect digital nerves other than the fourth, the predilection for which may be determined by anatomic peculiarities in composition. There is considerable evidence that trauma from weight-bearing in small or otherwise ill-fitting shoes is responsible for the pathogenesis of the lesion. In intractable cases the most promising treatment is resection of the affected nerve.—*Mary Frances Vastine.*

Rose, E. K., György, P., and Ingraham, N.R., Jr. Penicillin in the treatment of the syphilitic infant; progress report. *J. Pediat.*, Nov., 1946, *29*, 567–584.

This report supplements a previous report on the use of penicillin in the treatment of syphilitic infants. The authors point out that syphilis is a severe and more serious infection in the infant than in the adult. In the former the infection is more intense, more massive and interferes with tissue growth.

Thirty-six cases of congenital lues have been treated by the authors with penicillin. Criteria for inclusion in the study include a high or rising titer by serology for syphilis, a characteristic macular eruption or roentgen evidence of metaphysitis with or without periostitis. Six of these 30 cases had no roentgen evidence of bone lesions. Details of the dosage and clinical response are given. In general, the osseous changes showed characteristic involution on serial films. In 3 cases dactylitis showed roentgen progression before regression.

In 2 cases of osteochondritis treatment resulted in rapid calcium deposition at and around the metaphysis as a result of the healing process. From the illustrative films it is apparent that actual shaft infractions had occurred in these patients at the site of calcium deposition. In some infants rapidly progressive and destructive lesions became evident in the long bones under treatment. The authors compare this to similar changes occurring in acute progressive osteomyelitis. In each case rapid destruction of spirochetes or staphylococci occurs with elimination of necrotic debris followed by periosteal and soft tissue inflammatory reaction with subsequent osseous repair.

Recommendations are made as to total dosage although optimum time dosage relationship has not been finally determined.—*Rolfe M. Harvey.*

Caffey, J. Infantile cortical hyperostoses. *J. Pediat.*, Nov., 1946, *29*, 541–559.

The author has previously described 4 cases of this syndrome which is characterized by: (1) tender deep soft tissue swellings; (2) cortical thickening of the skeleton; and (3) onset during the first three months of life. Hyperostosis was found in the mandible, clavicles, scapulae, ribs, and the tubular bones of the extremities. The soft tissue swellings were in the approximate location of the skeletal changes.

Other occasional findings were fever, anemia and increased sedimentation rate. Recovery is spontaneous after weeks or months. The cause remains undetermined.

Caffey reports an additional 5 cases in this article. From these additional cases it is evident that the onset of the disease may be later than three months as originally reported. One of the present series had its onset at the tenth month and one at the twentieth month respectively.

Facial swellings were present in all 6 cases with an onset prior to the sixth month but not in those with a later onset. In 2 of the cases so far reported no fever has been detected during the course of the disease. There was no evidence of pleurisy in any of the 6 cases of the present series although it was present in 3 of the 4 cases originally reported. Pleurisy was noted in cases with extensive cortical rib thickening only.

It should be noted that there may be a lag of at least four weeks between the appearance of soft tissue swellings and evidence of roentgen changes in the bones.

In the differential diagnosis, periostitis, osteomyelitis and malignancy of the mandible, scurvy, poliomyelitis, leukemia and rheumatic fever must be considered.—*Rolfe M. Harvey.*

Dickson, Douglas D., Luckey, Clarence A., and Logan, Noble H. Infantile cortical hyperostosis. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 224–226.

A case of a full-term female infant is reported. The patient at the age of one week had orange juice and cod-liver oil included in its formula. At the age of two months, examination revealed a hard mass over the region of the right scapula with invasion of the right axilla. Roentgeno-

grams showed marked bony overgrowth of the right scapula with later involvement of the right clavicle. There was also considerable edema of the muscles over the right shoulder. Some cortical thickening of the mandible was demonstrated. Microscopic examination revealed invasion of the muscle with inflammatory cells. Final roentgen examination, nine months after the first observation, showed a normal bone pattern throughout the entire skeleton.

This case is similar to those reported by Caffey and Silverman who suggested the term, infantile cortical hyperostoses, for the syndrome.

The etiology in this case is obscure. Whether or not this patient showed a response to infection cannot be easily determined. The biopsy did not suggest that osteomyelitis was the cause. However, infants may respond differently than adults in the presence of a hematogenous osseous inflammatory lesion. It has been noted frequently that osteomyelitis in the infant is benign and produces no sequestra.—*R. S. Bromer.*

Mackenzie, William. Painful, non-suppurative, localized sclerosis of the long bones. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 49–58.

Two cases of painful, non-suppurative, localized sclerosis of long bones are reported. In each case a tibia was involved. The special feature of the case was the fact that the radiolucent area within the dense sclerotic portion was not sharply defined. In this respect the roentgenograms resembled those reported by Jaffe and Lichtenstein as osteoid osteomas. On microscopic examination the bone focus in the second case which was removed resembled the histopathological description of those writers.

Mackenzie expresses no opinion regarding the essential nature and cause of the lesion in both cases. The paper contains a short review of the literature of the sclerosing osteomyelitis of Garré and of osteoid osteoma.—*R. S. Bromer.*

Gillespie, H. W. The significance of minor bone injuries. *Brit. J. Radiol.*, May, 1946, *19*, 173–177.

In fractures, injury to the ligaments and muscles is often equal in importance to the bone damage. In many cases of minor fracture, it is evident that the importance of the damage to the soft tissue actually outweighs the bone injury. These fractures are commonly described as chip fractures or detachments of a small bone flake. The indirect diagnosis of "damaged ligament" rests on the fact that when the bone attachment of a ligament has undergone a strain, it rarely happens that the ligament is stripped off at the insertion, but that the ligamentous fibers are so firmly rooted in the bone that invariably a small bone fragment is avulsed. The attachment of the ligament remains intact, but the bone is broken.

The author describes and tabulates small chip fractures due to ligamentous damage as to the site of bone damage and the ligament affected. He similarly tabulates chip fractures due to avulsion of muscle and its tendons where the osseous damage equals or outweighs the soft tissue injury. Only a few of the more common injuries have been selected from the author's tables and listed below.

Bone Damage at:	Affected Ligament
1. Base of distal or middle phalanx of finger	1. Capsular interphalangeal ligament
2. Dorsal surface of os triquetrum or lunate	2. Posterior radiocarpal ligament
3. Styloid process of ulna	3. Medial ligament of wrist
4. Dorsal surface of tarsal navicular bone	4. Tibionavicular fasciculus of deltoid ligament
5. Dorsal surface of head of talus	5. Anterior talotibial fascicular of deltoid ligament
6. Dorsal surface of neck of talus	6. Anterior capsular ligament
7. Lower border of medial malleolus	7. Deltoid ligament
8. Styloid process of fibula	8. Lateral ligament of ankle
9. Lateral margin of tibia	9. Inferior tibiofibular ligament
10. Tibial spine	10. Anterior cruciate ligament
11. Tibial plateau	11. Post cruciate ligament
12. Avulsion fracture of posterior angle of base of terminal or middle phalanx of finger.	12. Tendon of extensor digitorum

—*K. K. Latteier*

Klinefelter, Edmund W. Ossification associated with chronic strain of the tibial collateral ligament from roller-skating. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 237–240.

Chronic strains of the upper half of the tibial collateral ligaments, which often occur among football players and skiers, do not result from the usual skating movements, but are produced by such movements as the "split" in figure skating. Subsequent to these strains, ossifications may develop in this part of the ligament. Similar ossifications, resulting from causes other than roller-skating, have received considerable discussion under the heading of Pellegrini-Stieda's disease. They have, in principle, the same significance and require the same treatment as those in the lower half of the ligament. The ossifications frequently produce symptoms and may interfere seriously

with the function of the attached ligaments and tendons.

The chronic strains are especially predisposed to develop in the obese woman with a square torso, protruding abdomen, and relatively long, thick legs, as she advances beyond the age of thirty-five years. In order to avoid collisions on crowded rinks, she is compelled to check her advance frequently, not by turning or gliding movements, but by throwing her weight on the inside wheels of the externally rotated skate as it is dragged against the floor; the same leg is practically always used for this purpose. Tremendous strain is thereby placed on the tibial attachments of the tibial collateral ligament, and of the popliteus and soleus muscles.

The development of the strain is gradual; the first symptoms rarely appear before at least three years of skating. A roentgenogram may show swelling of the tibial collateral ligament. Later osseous deposits are shown.

Roentgenograms are shown of 4 cases all of which occurred in women between forty-two and fifty-three years of age and with histories of roller-skating for periods ranging from twelve to thirty-one years. Osseous deposits and calcifications are shown in the medial collateral ligament.—*R. S. Bromer.*

Seligson, Frank. Poncet's disease; clinical observations on inflammatory and degenerative joint reactions in tuberculosis. *Am. Rev. Tuberc.*, Dec., 1945, *52*, 463–473.

The disease described by the author is based on two published books (Poncet, A., and Leriche R. Le rheumatisme tuberculeux. O Doin et Fils, Paris, 1909, 37–38, 40–41) (Poncet, A., and Leriche, R. La tuberculose inflamatoire. O. Doin et Fils, Paris, 1912). Poncet and Leriche call their clinical entity tuberculous rheumatism and describe numerous extrapulmonary conditions in the joints and other serous surfaces as being caused by the tubercle bacillus. They did not claim to find in all their cases the classical proof of tuberculosis, which means the positive guinea-pig test on inoculation and the typical pathological anatomical picture. They maintain that tuberculous rheumatism is only a clinical observation and state that while some of their cases meet the customary clinical requirements for the diagnosis of tuberculosis, very often the circumstantial evidence of clinical factors is considered as satisfactory proof of the tubercuous origin of the arthritic lesion. They were of the opinion that bacillary toxins cause the different types of tuberculous rheumatism.

Eight cases are reported in this paper which are believed to support Poncet and Leriche's observations. The author believes that the use of tuberculin treatment should have a new trial.—*James J. McCort.*

Krauss, Ruth F. Osteomyelitis caused by salmonella typhimurium. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 227–232.

The case reported is that of a white boy two and a half years old, suffering from septicemia caused by the *Salmonella typhimurium* and complicated by osteomyelitis of most of the ribs, the scapula, pelvic bones and femur. There was no sequestration in any of the lesions, and the architecture of the bones returned to normal much more rapidly and completely than in the ordinary case of osteomyelitis caused by the staphylococcus. Leukopenia was present at the onset of the illness. Agglutinins developed in fairly high titer (1 to 800) against the offending organism. *Salmonella* organisms were not recovered from the feces, urine or pharyngeal secretions.

Salmonella typhimurium was found in the blood culture and was also recovered from a culture of the material obtained by biopsy from the ilium. The histopathological examination of the biopsy specimen showed a very extensive osteitis and osteomyelitis.

In view of the repeated finding that salmonella osteomyelitis often is a relatively mild disease so that it may improve without surgical intervention, the author suggests that such cases may have escaped diagnosis. In the future it may be wise to examine roentgenographically the skeletons of patients suffering from salmonella septicemia, in order to determine the true incidence of salmonella osteomyelitis.—*R. S. Bromer.*

Sherman, Mary S., and Phemister, D.B. The pathology of ununited fractures of the neck of the femur. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 19–40.

This paper is a review of the pathological changes seen, following ununited fractures of the femoral neck. Nine cases are tabulated with histories, illustrations of roentgenograms and gross and microscopic specimens. The following are the authors' conclusions and summary:

1. The incidence of non-union is disproportionately high in intracapsular fractures of the neck of the femur, except in those which are either impacted or treated by accurate reduction and internal fixation. Factors entering into this high incidence are the frequent occurrence of death of the head fragment from disruption of the blood vessels of the neck, displacement of the fragment ends, poor immobilization, and failure of peripheral callus formation due to absence of a cambium layer on the neck.

2. If the head fragment survives, it undergoes atrophy of disuse of the same degree as that of the distal fragment, and the two fragments are of equal density on the roentgenogram. Treatment to produce union is usually successful and extensive degenerative changes in the joint do not occur.

3. If the blood supply to the proximal fragment is severed, so that the head dies, disuse atrophy cannot occur, and the head eventually appears on the roentgenogram to be more dense than the surrounding atrophic, living bone. As slow invasion of the head by vascular fibrous tissue occurs, with absorption of the necrotic bone and replacement by cancellous new bone, the roentgenogram shows areas of reduced density.

4. The necrotic articular cartilage remains relatively unaltered until a blood supply reaches it, when it is replaced either by an imperfect type of fibrocartilage or in part by bone.

5. Transformation of a dead head takes place first at the margins of the fracture and at the fovea, and the advancing replacement zone is the weakest part of the bone. Pathological fracture between the dead and living portions may result in collapse and delayed union or non-union.

6. If union has occurred, either primarily or as the result of surgical intervention in the presence of a dead head, and if weight-bearing is begun before replacement is complete, the head will probably collapse, and degenerative changes will be severe on both sides of the joint. If the head is adequately protected, it may be transformed without any collapse; the degenerative changes in the joint are minimal; and a good functional result is obtained.—*R. S. Bromer.*

Leveuf, Jacques. Primary congenital subluxation of the hip. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 149–162.

In cases of congenital dislocation, the author states that the French, contrary to the Anglo-Saxon authors, distinguish between luxation and subluxation. In the latter, according to recognized authorites, the head of the displaced femur remains in contact with a more or less deformed acetabulum. The importance of this distinction is even greater than was formerly thought. Leveuf's studies have shown that the primary subluxation of the hip presents some anatomical characteristics distinctly different from those of luxation. He has used arthrography, injection of the joint space with an opaque medium, since 1935, and he believes that this enables one to distinguish a subluxation from a luxation without difficulty, even in the youngest child.

Reduction by the closed method of a subluxated hip presents no great difficulty but in spite of orthopedic treatment, the articulation remains incongruent, and sooner or later, signs of a deforming osteoarthritis appear which eventually becomes a permanently disabling condition. The prevention of this forms the subject matter of this paper.

In the paper only primary subluxations are considered. The so-called residual subluxations which are sometimes observed after attempted bloodless reduction of true luxation of the hip, are quite different. They are characterized by the presence of interposed soft parts (limbus, round ligament and capsule) between the head and the acetabulum. Such interposition never occurs in primary subluxation.

The essential difference between subluxation and luxation is indicated by the position of the cartilaginous roof, formed by the union of the non-ossified part of the acetabular rim with the cotyloid fibrocartilage (also called the limbus). In a subluxation the limbus is forced upward and inward toward the iliac fossa; in a luxation the limbus is forced downward and inward toward the acetabulum. The worn down or shallow acetabulum is characteristic of subluxation, and not of luxation as is stated in orthopedic textbooks. In subluxation, the femoral head is deformed very early. In luxation, on the other hand, the head retains its regular contour for a long time. In subluxation the capsule, although enlarged, is never interposed between the femoral head and the acetabulum. In luxation, the capsule often is interposed between the head and the acetabulum, especially at the lower portion of the cavity. In subluxation, a valgus

deformity of the neck is often found. There is also anteversion of the neck. In luxation, there is no valgus of the neck. The anteversion is only found in very young subjects.

In regard to treatment, the author emphasizes that bloodless reduction must be checked rigorously by arthrography. The most favorable age for open reduction is around three years. The operation can be done on older subjects (fifteen years and over) provided the components of the articulation have not been deformed, especially by untimely orthopedic manipulations.

The roentgenograms which are reproduced demonstrate the use of arthrography. The solution used is a concentration of 30 per cent of ténébryl. This is identical with that used in urography and is rapidly eliminated, in approximately thirty minutes, without affecting the articulation. In conclusion, the author states that the articular surfaces must be in perfect alignment (perfectly congruent). This is the only way to prevent a later deforming osteoarthritis. Only by arthrography can one visualize in the roentgenogram the state of the soft parts, namely, the cartilage of the roof, the limbus and the capsule.—*R. S. Bromer.*

Bachman, A. L. Roentgen diagnosis of knee-joint effusion. *Radiology*, May, 1946, *46*, 462–469.

In the study of roentgenograms of knees of patients admitted to Station Hospital, Miami Beach Training Base, changes in soft tissues have been noted which have facilitated the diagnosis of effusion into the knee joint.

A description of the roentgen anatomy of the knee is given and, based on the anatomical considerations, the following roentgenographic signs were found:

1. A widened band of fluid density (the distended base of the suprapatellar pouch) in the lower portion of the area of fatty radiolucency between the posterosuperior angle of the patella and the femoral condyle. This is the most reliable sign.

2. Anterior pressure convexity, mainly of the upper hlaf of the infrapatellar fat pad.

3. Complete or nearly complete delineation of the pyriform fluid-filled suprapatellar bursa (in those cases where the bursae are surrounded by a thin rim of fatty tissue).

4. Anterior displacement of the patella.

5. Widening of the knee joint. In the 20 cases listed, in no case was distinct widening of the knee joint observed.—*F. B. Markunas.*

Guri, Jose Puig. The formation and significance of vertebral ankylosis in tuberculous spines. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 136–148.

In reviewing the cases of tuberculous spondylitis, the author noted that in a few cases the clinical healing of the process coincided with the roentgenographic appearance of a spontaneous fusion of the anterior spine. In the cases where a prolonged reoentgenographic follow-up was available, it was observed that these vertebral synostoses, or vertebral blocks, had been formed either by end-to-end contact of two or more vertebral bodies after destruction of the intervertebral disc and cartilaginous plates, or by recalcification and union of the remnants of several vertebral bodies which had been partially destroyed during the early stages of the disease. The amount of concurrent deformity of the spine, and shape, structure, and speed of formation of these synostoses, were not uniform.

Careful study of the spines which healed by the formation of vertebral synostoses showed that three main factors regulated the speed of their formation and final configuration: the topographical distribution of the infection, the pathomechanics of the different spinal segments, and the treatment. The different sources of blood supply to the different parts of a vertebral body explains the different topographical types which Guri, in spite of the complex variety of names suggested, basically reduces to three: anterior, central and epiphyseal. The formation of a vertebral synostosis is possible, in the great majority of cases, only after the approximation and superimposition of the affected vertebrae. This approximation can be performed either along a longitudinal axis (telescoping), by flexion in the sagittal plane of one spinal segment upon the other, or, in a minimum number of cases, by flexion in the frontal plane (the so-called tuberculous scoliosis). In the lumbar region a marked amount of telescoping may occur while it is minimum in the thoracic area. Forward flexion is most frequent in the thoracic region. Another factor that influences the final shape of the vertebral synostosis is the appearance of protective muscle

spasm. This produces, from the onset, a complete flattening of the lordosis in the lumbar spine, thus allowing uniform telescoping of the vertebral bodies in cases of the epiphyseal type. The amount of destruction that takes place in each vertebral body, the number of affected bodies, and the type of treatment are also factors influencing the final shape of the synostosis.

The formation of vertebral synostoses in tuberculous spondylitis in adults is discussed, first in cases of so-called epiphyseal spondylitis, and second in cases of central tuberculous involvement. Roentgenograms showing the types are reproduced. A section is also devoted to tuberculous spondylitis in children. Guri notes that in children, the division between epiphyseal and central types was not as definite as in adults. It was not infrequent to observe cases in which a primary epiphyseal infection extended far inside the vertebral body. It was much more common to observe involvement of several contiguous vertebral bodies than in adults. The number of cases in which a block could not be obtained was much higher in children than in adults.

In his conclusion, Guri states that the effects of a given treatment upon the evolution of a tuberculous spondylitis cannot be properly evaluated unless the different topographical types of tuberculous spondylitis, the number of infected vertebrae, the pathomechanics of the different spinal segments, and the alterations in the structure of the vertebral body produced by the infection are taken into consideration. Only after consideration of all these factors is it possible to understand why in some cases sound healing may take place in one and a half to two years after the onset of symptoms, while in other cases the process continues to progress for longer periods of time.—*R. S. Bromer.*

Gillespie, H. W. Radiological diagnosis of lumbar intervertebral disc lesions. *Brit. J. Radiol.*, Oct., 1946, *19*, 420–428.

There are several objections to the use of contrast medium in the diagnosis of intervertebral disc lesions: it is time-consuming; it is unpleasant to the patient; it is possibly dangerous by the production of arachnoiditis in some patients; a negative examination does not exclude the possibility of a small protrusion; and lesions other than a disc protrusion, such as hypertrophic ligamentum flavum, may produce a persistent defect in the opaque medium used. A statement of Dandy is given contending that a combination of symptoms, signs, and plain roentgenograms without myelography permits accurate diagnosis in 98 per cent of patients in whom defective discs cause backache with or without sciatica. The straight roentgen examination of the lumbosacral spine is not only valuable as an aid in confirming a clinical diagnosis, but Dandy believes that that examination alone can make the diagnosis in more than 50 per cent of cases.

The author presents evidence from 160 cases which were examined with straight roentgenograms and which were subsequently subjected to operation. The roentgen examination of the lumbosacral spine was normal in one-third of these. The other two-thirds showed changes which were interpreted as confirming the clinical diagnosis of a protruded disc. These finding were grouped as follows:

1. Narrowed cartilage space between two vertebrae.
2. Hypertrophic fringe formation.
3. Congenital anomalies.
4. Loss of lumbar lordosis.
5. Lumbar scoliosis.

In 31.2 per cent the first two elements were found to aid in showing the existence and localization of the disc. In older individuals narrowing may represent simple osteoarthritic change, but in individuals under forty years, the finding becomes more significant. Certain congenital anomalies, such as spina bifida, or spondylolysis may reduce structural stability, and this favors prolapse of a disc if trauma has occurred. The author attaches much less significance to abnormal curvatures of the spine than to the other elements mentioned.

In addition to the routine anteroposterior, lateral and oblique views, several other projections are suggested. These include examination with the patient upright, detail views with the central ray directed through the space to be investigated, and particularly, close-up technique, which is valuable in showing early osteoarthritic changes.

Emphasis is placed on the concept that a diagnosis can be based on typical clinical symptoms and signs with roentgen changes which would confirm these as to nature and location of

the lesion. The author feels that myelography is unnecessary.—*E. F. Lang.*

BLOOD AND LYMPH SYSTEM

King, David J. A case resembling hemangiomatosis of the lower extremity. *J. Bone & Joint Surg.*, July, 1946, *28*, 623–628.

King reports a case which presents a problem in diagnosis. He could find no report of a similar case. The microscopic picture of the lesion suggested that it involved the capillary system and he selected the title of this report for this reason. On gross examination, however, no extraneous blood vessels were encountered. Although both bone and soft tissue were involved, the primary lesion appeared to surround the great vessels of the limb.

The patient was an eleven year old white boy who fell from a bicycle and injured his left knee. Roentgenograms made one, and again three months later showed no involvement of bone. One year later he was admitted to the hospital for generalized swelling of the left lower extremity with discoloration above the knee, elevation of the skin temperature and with a fluctuant wave involving the thigh and upper half of the leg. Roentgenograms showed marked soft tissue swelling and destruction of bone in the distal third of the left femur. It was decided to examine the lesion at operation and amputate the limb. The microscopic sections were examined by four pathologists who considered the lesion to be some type of angioma. The suggestion was made that the changes found in the sections were associated with disease (anomalous or otherwise) of the general vascular system of the leg. The wound after operation healed per primam but the bogginess of the stump which developed continued for some time. Roentgenograms after operation (approximately seven months later) showed decreased calcification and punched-out areas in the remaining portion of the femur and in the acetabulum. Roentgen therapy was employed and was discontinued about a year after operation. Two years after operation the bogginess of the stump had disappeared and roentgenograms showed progressive improvement. It was felt that roentgen therapy was no longer needed. At the time of the writing of this report, the patient was being followed in the clinic.—*R. S. Bromer.*

ROENTGEN AND RADIUM THERAPY

Robbins, L. L., Aub, J. C., Cope, O., Cogan, D. G., Langohr, J. L., Cloud, R. W., and Merrill, O. E. Superficial "burns" of skin and eyes from scattered cathode rays. *Radiology*, Jan., 1946, *46*, 1–23.

This article reports the varying degrees of injury received by six men in the Department of Radiology of the Massachusetts General Hospital as a result of a few seconds' exposure to scattered electrons from a 1,200 kv. electrostatic generator. This report is of importance to those working with supervoltage generators. There are no previous reports in the medical literature of injuries due to scattered cathode rays.

Because of a wandering focal spot on the supervoltage treatment machine, the target was renewed and a cathode-ray window inserted. With the latter window in place the focal spot could be located by inserting a film beneath the window and burning a hole in it with very short exposure.

Six men were in the room while the machine was running not longer than two minutes. Each of the six stood at least 3 to 5 feet or more feet away from the central beam and at right angles to it. At one point all leaned down and for five seconds looked at the cathode-ray window.

After it was apparent that these men had received burns, ionization measurements were made to determine the dose and depth of penetration of the radiation received. It was determined that those who stood 100 cm. from the cathode port for twenty seconds received a skin dose of about 1,000 r on their faces and 2,000 r on their hands.

It appears logical to expect that the effect of a given tissue ionization dose will be the same for a 1,000 kv. cathode ray as for roentgen rays of similar wavelength, since the ionization from roentgen rays is largely produced by secondary electrons with velocities approaching those and the electrons striking the target, and the damage to the tissues is also probably due to the effects of these electrons or the ions they produce.

The article gives detailed descriptions of the extent of the burns each man received.—*J. H. Harris.*